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THE ASSOCIATIVE BASIS OF THE CREATIVE PROCESS.

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RESEARCH WAS CONDUCTED TO FOCUS ON AN EXAMINATION OF SEVERAL ASPECTS OF THE CREATIVE PROCESS AS WELL AS ON THE DEVELOPMENT OF A TEST OF CREATIVE THINKING. THE SPECIFIC OBJECTIVES WERE (1) TO CONSTRUCT A TEST WHICH WILL MEASURE CREATIVITY AT THE HIGH SCHOOL LEVEL, (2) TO IDENTIFY THE VARIABLES THAT ARE EFFECTIVE IN INFLUENCING THE CREATIVE PROCESS, AND (3) TO REFINE A THEORY OF CREATIVE THINKING. A NUMBER OF STUDIES USING DIFFERENT METHODS WERE PURSUED--(1) A DEVELOPMENT OF THE REMOTE ASSOCIATES TEST (RAT), A TEST OF CREATIVE THINKING, WHICH IS DERIVED FROM AN ASSOCIATIVE THEORY OF CREATIVITY, AND (2) STUDIES OF THE CREATIVE PROCESS IN TERMS OF ASSOCIATIVE THEORY. THESE STUDIES, RELATED TO EACH OTHER IN THAT ALL TEST HYPOTHESES STEMMED FROM AN ASSOCIATIVE THEORY, WERE (1) CONTINUAL ASSOCIATION AS A FUNCTION OF LEVEL OF CREATIVITY AND TYPE OF VERBAL STIMULUS, (2) AN ASSOCIATIVE INTERPRETATION OF VERBAL RELATEDNESS, (3) INCUBATION OF CREATIVE PERFORMANCE AND SPECIFIC ASSOCIATIVE PRIMING, (4) CREATIVITY AND THE NEED FOR NOVELTY, (5) SOME EFFECTS OF CONFLICT IN CREATIVE THINKING, (6) CREATIVE POTENTIAL AND CHILDHOOD ANTECEDENTS, (7) FACTORS AFFECTING THE MANIFESTATION OF CREATIVE ASSOCIATIVE RELATEDNESS IN VERBAL TRANSFER. EACH OF THE NINE SEPARATE STUDIES HAD THEIR OWN INDEPENDENT EXPERIMENTAL DESIGN WHICH INCLUDED OBJECTIVES, PROCEDURE RESULTS, AND CONCLUSIONS. (HB)

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THE ASSOCIATIVE BASIS OF THE CREATIVE PROCESS

Cooperative Research Project No. 1073

Sarnoff A. Mednick and Martha T. Mednick

University of Michigan
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PART I

THEORETICAL ORIENTATION AND RESEARCH BACKGROUND

INTRODUCTION

The research conducted during the present contract focussed on two major problems. These were (1) elaboration and testing of an associative theory of the creative process, and (2) the development of a test of creativity, the Remote Associates Test (RAT). The two areas overlap considerably; the development of the RAT, as an operationalized statement of the theoretical definition of creativity, is in itself an attempt at theory testing and clarification. Furthermore, subject selection for various experimental tests of the theory was usually based upon RAT scores. Nevertheless, the logical and pragmatic separation between the two major problem areas does exist and is reflected in this report. The report begins with an initial section covering the theoretical and research background of the test and a brief discussion of some related work by other investigators. Part II covers the development of all forms of the RAT; Part III is a series of papers covering our work on associative theory. Since different aspects of the theory were tested, and varying methodologies used, these were presented separately. A summary chapter closes the report.

CHAPTER 1

THE ASSOCIATIVE BASIS OF THE CREATIVE PROCESS[1]

Creative individuals and the processes by which they manifest their creativity have excited a good deal of interest and curiosity. There are extended analyses of novels and novelists, poems and poets, mathematics and mathematicians, both biographical and autobiographical. Perusal of the introspections of manifestly creative individuals uncovers a surprising vein of similarity in the processes they describe (Ghiselin, 1952). Thus we find Albert Einstein's self-searching to suggest that "The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which seem to be the essential feature in productive thought." Samuel Taylor Coleridge is described as having developed his ideas in the following manner: "Facts which sank at intervals out of conscious recollection drew together beneath the surface through the almost chemical affinities of common elements." In the field of art, we find André Brêton referring to a collage by Ernst as being distinguished by a "marvelous capacity to grasp two mutually distant realities without going beyond the field of our experience and to draw a spark from the juxtaposition." Most explicit, however, is the oft-quoted statement by the mathematician, Poincaré, who talks about an evening when "ideas rose in crowds; I felt them collide until pairs interlocked so to speak, making a stable combination. By next morning I had established the existence of a class of Fuchsian functions." From these experiences, Poincaré felt that he could state that "to create consists of making new combinations of associative elements which are useful. The mathematical facts worthy of being studied . . . are those which reveal to us unsuspected kinships between other facts well known but wrongly believed to be strangers to one another. Among chosen combinations the most fertile will often be those formed of elements drawn from domains which are far apart." In a totally different area, an exceptionally compelling illustration of a useful combination of elements "drawn from domains which are far apart" occurs in the line from the poem, "The Monkey Puzzle" by Marianne Moore (1951), "The lion's ferocious chrysanthemum head." The ideas, "ferocious" and "chrysanthemum," are reconciled by the mediation of the "lion's head."

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[1] This chapter is mainly the work of S. Mednick. A similar paper has been published in the Psychol. Rev., 1962, 69, 220-232.

With these introspective statements serving as background, we may proceed to define the creative thinking process as the forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution. An additional criterion of the level of creativeness of a product is described below.

Creative thinking is defined here as distinguished from original thinking by the imposition of requirements on originality. Thus, 7,363,474 is quite an original answer to the problem "How much is 12 + 12?" However, it is only when conditions are such that this answer is useful that we can also call it creative. There are many original ideas expressed in institutions for the mentally ill; however, few of these are likely to be considered creative.

It should be pointed out that this definition of creativity is quite similar to basic notions advanced by British associationists from Locke (1690) to Bain (1855), and by those psychologists whose work is based in large measure on their speculations. Freud (1938), Hollingsworth (1928), and Binet (1899) may serve as examples.

Ways of Achieving a Creative Solution

In terms of associative theory, we may point to three ways of achieving a creative solution. Generally, any condition or state of the organism which will tend to bring the requisite associative elements into ideational contiguity will increase the probability and speed of creative solution. Therefore, the following three ways of attaining solutions are all methods of bringing the requisite elements together.

Serendipity. The requisite associative elements may be evoked contiguously by the contiguous environmental appearance (usually accidental) of stimuli which elicit these associative elements. This sort of creative solution is often dubbed serendipitous. This is the manner of discovery to which is popularly attributed such inventions as the X-ray and such discoveries as penicillin. One physicist has described how he has reduced serendipity to a method by placing in a fishbowl large numbers of slips of paper, each inscribed with a physical fact. He regularly devotes some time to randomly drawing pairs of these facts from the fishbowl, looking for new and useful combinations. His procedure represents the operational embodiment of this method of achieving creative solutions.

Similarity. The requisite associative elements may be evoked in contiguity as a result of the similarity of the associative elements or the similarity of the stimuli eliciting these associative elements. This mode of creative solution may be encountered in creative writing which exploits hymonymity, rhyme, and similarities in the structure and rhythm of words or similarities in the objects which they designate. The contiguous ideational occurrence of such items as alliterative and rhyming associates may be dependent on a factor such as primary stimulus generalization. It seems possible that this means of bringing about contiguity of associational elements may be of considerable importance in those domains of creative effort which are less directly dependent on the manipulation of symbols. Here we might include certain approaches to painting, sculpture, musical composition, and poetry.

Mediation. The requisite associative elements may be evoked in contiguity through the mediation of common elements. This means of bringing the associative elements into contiguity with each other is of great importance in those areas of endeavor where the use of symbols (verbal, mathematical, chemical, etc. . . .) is mandatory. For example, in psychology, the idea of relating reactive inhibition and cortical satiation may have been mediated by the common associates "tiredness" or "fatigue" (Kohler & Fishback, 1950).

Individual Differences

From the definition given above, we may deduce the factors that will make for individual differences in the probability of achieving creative solutions. Any ability or tendency which serves to bring otherwise mutually remote ideas into contiguity will facilitate a creative solution; any ability or tendency which serves to keep remote ideas from contiguous evocation will inhibit the creative solution.

Listed below are several illustrative predictions concerning individual differences that one may make from this theoretical orientation.

Need for Associative Elements. It should be clear that an individual without the requisite elements in his response repertoire will not be able to combine them so as to arrive at a creative solution. An architect who does not know of the existence of a new material can hardly be expected to use it correctly. The necessity of a thorough technical grounding in one's field of specialization should not be therefore understressed in educational planning. Without content, there can be no recombination.

Associative Hierarchy. The organization of an individual's associations will influence the probability and speed of attainment of a creative solution. There is a whole family of predictions that one may draw from this concept of the associative hierarchy. As an initial example, let us take the question of the manner in which the associative strength around ideas is distributed. If we present an individual with the word "table," what sort of associative responses does he make? The individual who tends to be restricted to the stereotyped responses such as "chair," may be characterized as having an associative hierarchy with a steep slope (see Figure 1). That is, when you get past the first one or two conventional responses to the stimulus, associative strengths to other words or ideas (lower in the hierarchy) drop rapidly. We can also conceive of a second sort of individual whose associative hierarchy is characterized by a rather flat slope. This is an individual who perhaps also has as his strongest response, the conventional "chair." But for him this response is not overly dominant and so it is more likely that he will be able to get to the less probable, more remote, associations to "table." It is among these remote responses that the requisite elements and mediating terms for a creative solution will be lurking. It would be predicted from Figure 1 that the high creative subject (flat hierarchy) would respond relatively slowly and steadily and emit many responses while the low creative subject (steep hierarchy) would respond at a higher rate but emit fewer responses. A test of this hypothesis is reported in Chapter 1 of Part III of this report.

It would also be predicted that the greater the concentration of associative strength in a small number of stereotyped associative responses (steep hierarchy) the less probable it is that the individual will attain the creative solution. Thus, the word association behavior of the high creative individual should be characterized by less stereotypy and commonality than the low creative. This last prediction is supported by a study by Mednick, Gough, and Woodworth (Mednick, 1958).

The prediction suggesting an expectation of less creativity from an individual with a high concentration of associative strength in a few responses leads to another prediction. The greater the number of instances in which an individual has solved problems with given materials in a certain manner, the less is the likelihood of his attaining a creative solution using these materials. Such an individual will "know the meaning" of the elements of the subject matter. That is, he will have a steep associative hierarchy around these elements. An example of the operation of this principle recently occurred to the senior writer while teaching an honors freshman introductory course in psychology at the University of Michigan. He was giving a well known interpretation of a well known experiment in stimulus generalization when interrupted by a student who calmly stated that the interpretation was in error. He asked him to explain. His explanation proved him to be correct. As a teacher he has been dealing with this material for years and "knew" the "correct" interpretation; for the student, this material was new, he had a low, flat associative hierarchy. Thus, if a newcomer to a field has the requisite information, he is more likely to achieve a creative solution than a long-time worker in the field. This may be the reason that theoretical physicists and master chess players are often said to have passed their prime by the age of 25. Indeed, it may be worthwhile to encourage such brilliant men to switch to a new field when reaching the point at which their hierarchy becomes steep. The fishbowl of the physicist is another form of antidote.

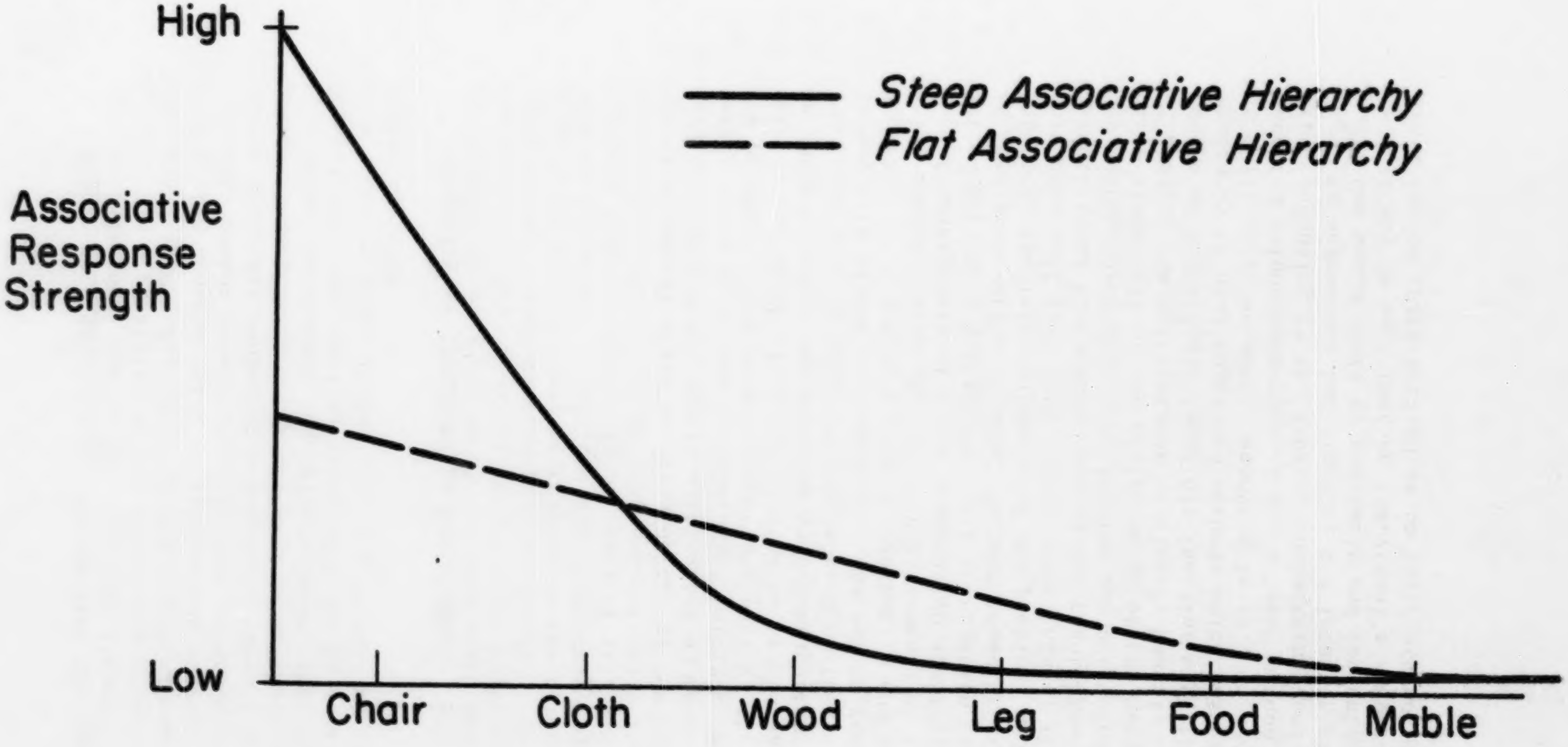

Fig. 1. Depiction of flat and steep associative hierarchies for the word "table."

Number of Associations. The greater the number of associations that an individual has to the requisite elements of a problem, the greater the probability of his reaching a creative solution. This variable is not independent of the preceding one since an individual with a high concentration of associative strength in a few associative responses cannot have a proliferation of associations. The more associates which are evoked by a requisite element of a problem, the more likely it is that an associate will exist which will serve as a mediating bridge to another requisite element, facilitating combination. It seems likely that this variable will not be related to speed of creative solution since it may take a good deal of time to get to the mediating links.

Selection of the Creative Combination. The creative combination of elements is only one among the many which may present themselves to the subject. How or why is the creative combination selected? Some speculations regarding this problem follow. The explanation of the process of selection may be related to the nature of the problem. Problems either entail a specific and relatively objective set of testable criteria (paint a realistic portrait of this individual, design a refrigerator so that it will be automatically free of frost) or they do not (the chemist mixes two liquids out of curiosity; the painter dabs hopefully at a fresh canvas waiting for an idea; the psychologist tosses a new test into a correlation matrix). When specific criteria are provided, they form an important part of the stimulus set which is determining which associative elements are being elicited and thus becoming eligible for entering into combination with other elements. Important sets of associations to each of these combinations are the consequents of the combinations. The set of consequents for each combination (if I put x, y, and z together, a and b will happen) is continually compared with the set of requirements of the problem. When the set of consequents of a new combination achieves a close fit with the set of problem requirements, this combination is selected. When there is complete overlap of sets, "search behavior" is terminated. As with the other requisite elements of the problem, individual differences in this case will vary with (among other things) the structure of the associational hierarchies around the requirements of the problem. When the refrigerator-defroster problem was presented to an undergraduate class almost all of the proferred solutions were based on the principle of ridding the refrigerator of already heavily accumulated frost. A couple of individuals (possibly familiar with the defroster principles presently in use) suggested methods which disposed of the frost before it built up to an overly annoying level. In addition to these there were two unique responses, i.e., a "new" method of preventing moisture from condensing in the freezer compartment, and a method of allowing frost to accumulate but limiting the location of accumulation to a small box which could be regularly and conveniently removed and emptied. Thus it may be seen that an individual's associations to the requirements may be characterized as to their stereotypy; the imposed requirements of the problem may be viewed as part of the requisite elements in the situation. The earlier theoretical statements concerning these elements may be seen as being relevant here. The foregoing suggests an explanation of the selection process for the case where the subject must hunt for a combination of elements which will satisfy given criteria. In the case where no criteria are specified, the subject is typically producing random combinations of elements; the task of selection in this case consists in finding relevant criteria for the given partial products.

If we may continue along a bit further with this example of the defroster, we may begin to see some glimmerings of a solution to the most serious problem in research on creative thinking--how may we determine to what degree behavior is creative? We have suggested one criterion in our hypothesis. In the following an additional criterion is developed. To begin with let us examine the requirements as originally stated--"Design a refrigerator so that it is automatically free of frost." The first thing that strikes us is that while some requirements have been stated, there are even more that are strongly implied and essential, many that are desirable, and a number that we would only become aware of after some method of satisfying them had been suggested.

Let us examine some possible solutions:

1. Simply refraining from opening the refrigerator door would solve the problem as stated since this would prevent moisture from entering and condensing as frost. This solution meets many of the implied requirements. It is cheap, convenient, effective, does not require special training, etc. However, it is not an optimal solution since it violates one essential, implied requirement--the usefulness of the refrigerator must not be impaired. (This is the cutting-off-your-nose-to-spite-your-face solution.)

2. A primitive solution is the hammer-and-screwdriver method. This is tried and true and meets many of the essential requirements. It falls down in that it is an inconvenient, messy, uneconomical (when caked with frost, the refrigerator unit is very inefficient), and endangers the mechanism, and is hardly automatic.

3. In a refrigerator we once owned another solution was used. The opening and closing of the refrigerator door operated a counter. At a certain count the refrigerator unit was automatically heated and the melted water evaporated outside the refrigerator. The superiority of this solution is immediately apparent. The source of this superiority lies in the number of requirements which it meets. It is economical automatic, convenient, peculiarly appropriate (the operation of the heating element is contingent upon the number of door openings; the amount of frost accumulated is also in part dependent on the number of door openings), does not interfere with the normal use of the refrigerator, and does not require special training. Note that the principle behind this highly creative solution (not allowing massive build-ups of

frost) was infrequently suggested in the classroom group. However, this solution is not wholly successful at meeting some criteria. The frequent heating and cooling may injure frozen food stored near the heating element. Secondly, since the heating process must be brief and mild, it is inevitable that not all frost is removed. While this solution does effectively curtail the number of defrostings, it does not eliminate them completely. It is clear that a method which would encompass all of the advantages of the "counter" method, but which would, in addition, eliminate defrosting altogether would be even more creative. What is suggested by this discussion is that the creativeness of a product is some function of the number of requirements that the product meets. The most ready application of this definition will be laboratory research in which tasks, solutions, and requirements may be arbitrarily constructed and varied.

CHAPTER 2

DEVELOPMENT OF THE REMOTE ASSOCIATES TEST

The associative definition of the creative process has suggested a way of testing for individual differences in creativity. The test items are intended to require the testee to perform creatively. That is, he is asked to form associative elements into new combinations by providing mediating connective links. Since the test situation is contrived, the specified criteria that are met are experimenter-imposed.

The definition dictates the structure of the test. We must provide stimulus items from two mutually-distant realities and ask the subject to "draw a spark from their juxtaposition." To state it more usefully, we must provide stimulus elements from mutually-remote associative clusters and have the subject find a criteria-meeting mediating link which combines them. A first problem concerns the type of material of which the stimulus item should be composed. If the test is to be appropriate for all fields of creative endeavor, the material must either be nonsensical so as to avoid bias favoring any specific means of creative expression, or it must be so common in society that high familiarity can be assumed across different fields of interest. The problems involved in constructing the nonsense materials so as to avoid favoring any interest groups soon proved to be apparently insurmountable. This left us searching for materials with which most individuals in the culture could claim acquaintance; this, in turn, brought us to verbal materials. While it may be true that certain occupational groups have extensive experience in dealing with words, there are some verbal associative habits that could reasonably be assumed to be familiar to almost all individuals that have been brought up in this (USA) culture. Among such habits are the associative bonds between words like "ham and eggs," "bed-bug," "pool-hall," "hound-dog," "whole-wheat," "chorus-girl," "kill-joy," and "red-hot." These became the materials for the test. Such materials could be found in any culture.

Having decided upon the materials, the test almost constructed itself in accordance with the definition. Several words from mutually-distant associative clusters must be presented to the subject; his task must be to provide mediating links between them. Further (a factor of extreme importance), the mediating link must be strictly associative, rather than being of a sort that follows elaborate rules of logic, concept formation, or problem solving. In their final (or at least present) form, the test items consist of sets of three words. One example might be:

Example 1: rat blue cottage

The subject is required to find a fourth word which could serve as a specific kind of associative connective link between these disparate words. The answer to Example 1 is "cheese." "Cheese" is a word which is present in the word pairs "rat-cheese," "blue-cheese," and "cottage-cheese." The subject is presented with several examples so that he has an adequate opportunity to achieve the specific set necessary for the task.

Example 2: railroad girl class
Example 3:[1] surprise line birthday

The test is called the Remote Associates Test, abbreviated RAT. The instruction page of the test is in the Appendix. The first form of the RAT was developed at the Institute of Personality Assessment and Research, at the University of California, by the senior author. It has been used with college undergraduates, graduate students, and various professional groups. A considerable body of data has been accumulated on RAT-Form 1[2] over the past few years. In the following section we present a brief survey of some of the results which encouraged us in the early stages of our research.

Early Research Results[3]

A basic question raised with respect to the usefulness of any test is what is being measured. The problem of the criterion in creativity research, discussed in detail later in this report, are rather complicated and not yet solved to everyone's satisfaction. Nevertheless, the first validity study conducted used ratings of students' creativity obtained from design course instructurs at the University of California College of Architecture as a criterion of creativity. These ratings form an unusually good criterion of creative performance since the instructors had been advising and evaluating the students in the actual creation of new designs and models of structures. They had been working with these students for at least a year and in many cases two or more, and were very well acquainted with their work. These ratings and RAT scores correlated significantly ($r=.70$, $df=19$, $p < .01$). In this study a preliminary version of the RAT was used.

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[1] Answers: 2. working
3. party

[2] Co-authored with Sharon K. Halpern.

[3] Only brief summaries of these findings will be presented.

In another approach to the assessment of validity, we explored the correlation of the test with other measures. Of great interest and potential significance is the fact that there seems to be a negative correlation with undergraduate grades. In one group, matriculating at a large technology institute, it was found that RAT scores and grade point average correlated -.27 In a study by Miller (1960) it was found that high RAT scorers tended to get higher grades from teachers rated as flexible than from teachers rated as dogmatic; for low RAT scorers the flexibility of the teacher was irrelevant. The correlation of verbal ability, such as measured by the Miller Analogy Test and the Terman Concept Mastery Test, and RAT ability varies from .30 to .40 in different groups.

In the area of social attitudes, Kowalsky (1960) found that high RAT-scoring female undergraduates had more atypical and "liberal" attitudes on sexual morality and womens' rights than a low scoring group. On the Strong Vocational Interest Blank the high RAT group had "significantly higher interest scores on the artist ($p < .05$), psychologist ($p < .005$), physician ($p < .025$), mathematician ($p < .025$), and author-journalist ($p < .05$) keys. The low creative group showed higher interest on the farmer ($p < .05$), math-physical science high school teacher ($p < .05$), office manager ($p < .05$), and pharmacist ($p < .01$) keys" (p. 19). (These are the probability values of obtained chi squares.) The only one of these keys related to ACE scores was that of physician. "The commonality of these interest patterns was evaluated by noting the per cent overlap of the specific key with the general population of interest expression. For example, the Farmer key overlaps 45% with the general population, while the Artist key overlaps 20%" (p. 20). The significant keys of the higher creatives had significantly less commonality than the significant keys of the low creatives. These differences were independent of the influence of intelligence as measured by the ACE.

At the Institute of Personality Assessment and Research, RAT was included as part of the assessment battery administered to a group of forty highly eminent architects. For this group the RAT correlated .31 with the Originality (O-I) Scale of the IPAR Questionnaire Scale and -.31 with the total Conformity Score obtained in the Crutchfield Conformity Experiment (Crutchfield, 1955). Interviewers rated high scorers as significantly higher in "graceful and well-coordinated in movement" and "reticent and taciturn in speech." The college grade point average which the subjects reported correlated -.34 with RAT score, a result which conforms to the findings reported above.

In the discussion of illustrative predictions it was suggested that highly creative individuals would be characterized by a flat associative hierarchy rather than a steep associative hierarchy. Further, it was proposed that the greater the number of associations that an individual has to the requisite elements of a problem, the greater the probability of his reaching a creative solution. From these two independent statements it may be deduced that when required to display his reservoir of associations to single stimulus words, the highly creative individual will have more access to less probable associates and therefore produce more associates. A study by Craig and Manis (personal communication) supports this deduction. Thirty-eight college students had the RAT and an association task administered to them. In the latter task they were given one minute to write as many associates as they could to each of twenty words. The correlation of the number of such associates with RAT scores was .38 ($p < .01$).

In two related studies, Karp (1960) and Kowalski (1960) found RAT scores to be directly related to the originality and quantity of anagrams constructed using the test word "Generation." In the Karp study 40 undergraduates were given 5 minutes to produce as many four letter anagrams from the test words as they could. The productions were scored for quantity (number of acceptable answers) and originality (a weighted score for each response was developed from the frequency with which the response was given by the 40 subjects). The correlation of the RAT with the quantity scores was .44 ($p < .01$); the correlation of the RAT with the originality score was .37 ($p < .05$). Kowalski presented the anagrams task to 15 high RAT scorers and to 15 low RAT scorers, giving them 5 minutes to produce words of any length from the test word "Generation." In this study originality was measured by computing the percentage of responses given by an individual which had not been given by any other of the 30 subjects. The difference on this measure between high and low RAT scorers was significant ($U = 68$, $p < .04$). "Only four subjects in the low creative group gave any original responses at all while eleven subjects in the high creative group did (p. 19).

Thus it can be seen that a good deal of encouragement with respect to the value of the test and the theory was obtained from our early work. It seemed that a further investment of effort was indeed warranted both with respect to the development of the test and to further experimental verification of the theoretical approach.

PART II

TEST DEVELOPMENT: IDENTIFICATION OF CREATIVE POTENTIAL

CHAPTER 1

FORM 1 OF THE REMOTE ASSOCIATES TEST; ADDITIONAL RESEARCH AND NORMATIVE DATA

In the first part of this report we covered the theoretical background of our research problem, described the development of the Remote Associates Test, and reviewed pre-contract research results. We turn now to a detailed presentation of the research conducted during the contract, beginning with the work on further development of the test.

The purposes of the continued work on Form 1[1] were to accumulate normative data from a variety of populations at the college and professional levels, and to further evaluate the test's reliability. Validity work done on all forms is presented separately in Chapter 3 of this part of the report.

Accumulation of Normative Data. Table 1 presents means and standard deviations of various populations and their subgroups for Form 1.[2] Table 2 presents score equivalents in percentile form for the different groups. The relative levels of the groups speak for themselves.

Reliability. The internal reliability of RAT, Form 1, was evaluated on a sample of 215 University of Michigan male college students. The mean score for this group was 17.1 with a standard deviation of 5.28. Using the Spearman-Brown formula (Guilford, 1956), the odd-even reliability was estimated at .91. A second check on the internal consistency of RAT, Form 1, was made on a group of 289 Bennington College women. In this case, the mean score was 18.22, with a standard deviation of 4.9. The odd-even reliability, again estimated by the Spearman-Brown method, was .92.

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[1] A 30-item test.

[2] Acknowledgment to persons contributing data has been made in a listing in the Appendix.

TABLE 1

REMOTE ASSOCIATES TEST--FORM 1
MEAN SCORES AND STANDARD DEVIATIONS

Group	N	Mean	SD
University of Michigan			
Undergraduates	2786	16.41	5.23
Males (total)	1882	15.95	5.39
Females (total)	904	17.36	4.62
Freshmen			
Males	653	17.45	4.71
Females	1202	15.46	5.30
Liberal Arts	824	17.34	4.93
Engineering	454	15.24	5.17
Architecture and Design	131	16.51	5.56
Nursing	110	16.84	3.66
Honors students	79	19.30	4.75
Psychology Graduate Students	81	20.10	4.00
University of California at Los Angeles--Freshmen	1036	16.02	5.54
Males	457	15.31	5.52
Females	579	16.73	5.42
University of Maryland--Undergraduates	73	13.14	4.80
Bennington College	288	18.00	4.90
Research Scientists	370	19.13	5.13
Professional Groups			
IBM Systems Research Institute trainees	47	19.32	4.65
IBM Scholarship and Fellowship applicants	75	19.03	4.09
IBM Engineers	48	17.38	5.54
IBM Suggestion winners	22	13.32	4.76

TABLE 2

REMOTE ASSOCIATES TEST, FORM 1
PERCENTILE SCORE EQUIVALENTS OF RAW SCORES

Percentiles	University of Michigan (UM) Undergraduate Groups				
	UM Male	UM Female	UM Male Freshmen	UM Female Freshmen	UM Liberal Arts
99	28+	28+	29+	28+	28+
95	25	25	25	25	26
90	23	24	23	24	24
85	22	23	22	23	24
80	21	22	21	22	23
75	20	21	20	21	23
70	19	21	19	21	22
65	18	20	18	20	21
60	17	19	18	19	20
55	16	18	17	19	19
50	16	18	16	18	18
45	16	17	15	17	17
40	15	17	15	17	17
35	13	16	14	16	16
30	13	15	13	15	15
25	13	14	12	14	14
20	12	13	11	13	13
15	10	13	10	13	12
10	08	11	09	12	11
05	06	10	07	10	09
01	04	07	04	05	06

TABLE 2--(CONTINUED)

Percentiles	University of Michigan (UM) Undergraduate Groups				
	Total UM	UM Senior	UM Junior	UM Sophomore	UM Freshmen LSA
99	28+	28+	28+	29+	28+
95	25	27	26	26	26
90	24	25	25	24	24
85	22	23	24	23	23
80	22	22	22	22	22
75	21	21	22	21	22
70	20	20	21	20	21
65	19	19	20	20	20
60	19	18	19	19	19
55	18	17	19	19	19
50	17	17	18	18	18
45	16	16	17	17	17
40	15	16	17	16	17
35	14	16	16	16	16
30	13	15	15	15	15
25	13	15	14	14	14
20	12	14	13	14	13
15	10	13	12	13	12
10	09	11	11	11	11
05	07	10	09	09	10
01	05	06	06	02	06

TABLE 2--(CONTINUED)

Percentiles	University of Michigan (UM) Undergraduate Groups					
	UM Eng.	UM Freshmen Eng.	UM A & D	UM Ed.	UM Nursing	UM Honors
99	28+	28+	28+	26+	26+	29+
95	24	24	26	24	23	27
90	23	22	25	23	21	26
85	21	21	23	22	20	25
80	20	20	22	21	20	24
75	20	19	21	21	19	23
70	19	19	20	20	18	23
65	18	18	18	19	16	22
60	18	17	18	19	16	21
55	17	16	17	18	15	20
50	16	15	16	17	15	20
45	15	14	16	17	14	19
40	14	13	16	16	14	19
35	13	13	14	15	14	19
30	13	12	14	14	13	18
25	12	11	14	14	12	17
20	12	10	13	13	11	16
15	10	09	12	12	10	14
10	09	08	10	11	09	13
05	07	07	08	09	07	11
01	02	04	00	07	03	08

TABLE 2--(CONTINUED)

Percentiles	Undergraduates				
	UCLA Total	UCLA Male	UCLA Female	Bennington College Total	U. of Maryland Total
99	28+	27+	29+	28+	26+
95	26	24	26	27	22
90	24	23	24	25	21
85	22	22	23	23	19
80	21	21	22	22	18
75	20	20	21	22	17
70	20	19	20	21	17
65	19	18	19	20	16
60	18	18	19	20	16
55	17	17	18	19	15
50	17	16	17	19	14
45	16	15	17	18	14
40	15	14	16	16	13
35	14	13	15	15	12
30	14	12	14	15	12
25	13	12	14	15	11
20	12	11	13	14	10
15	11	10	12	14	09
10	09	08	10	13	08
05	07	06	08	12	07
01	03	02	04	06	05

TABLE 2--(CONTINUED)

Percentiles	Research Scientists and Graduate Students	
	Graduate Students	Research Scientists
99	28+	28+
95	27	27
90	26	26
85	25	25
80	25	24
75	24	23
70	23	23
65	22	22
60	22	21
55	21	21
50	21	20
45	20	20
40	19	19
35	19	18
30	18	18
25	17	17
20	17	16
15	15	15
10	14	13
05	12	11
01	03	05
	(N = 136)	(N = 370)

CHAPTER 2

DEVELOPMENT OF NEW FORMS OF THE REMOTE ASSOCIATES TEST

2.1. High School Forms: (Forms 3 and 4)

Form 1 of the RAT evolved from a 100 item battery used for about one year with various groups of college undergraduates. The answer words to the items were Kent-Rosanoff (K-R) stimulus words, and the three words in the item were chosen from among low probability (.04 and less) responses in the Russell-Jenkins K-R word association norms (1952). All words used as stimuli in an item were AA (an occurrence of 100 or over per million words in written English) in the Thorndike-Lorge word count (1944). Thus the K-R stimulus word was the correct answer to an item composed of three low probability responses to that word. For example, "shopping, washer, picture" were words given by .1%, .3%, and .4%, respectively, of the population in response to the (item answer) word "window."

Unfortunately, norms existed at that time[1] for relatively few words; therefore, while advance knowledge of probability of associative connection would be ideal, this was not possible in the construction of subsequent forms of the test. Consequently, we used the following *a priori* method of item construction.

A battery of 400 items was the starting point of the development of the high school RAT. These items had been written by an individual familiar with the language usage of high school students;[2] in addition, a small group of high school students were asked to judge the familiarity of the associative pairs. None of the stimulus or answer words were above the third grade reading level. After being subjected to an item analysis and being revised twice, the pool of items resulted in two 40 item forms.

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[1] Jenkins and Palermo (1964) have published new and more extensive word association norms which can be used in future item construction work.

[2] The excellent assistance of Charles C. Jung in this task is acknowledged.

Item Analysis Procedure[3]

The 400 items were divided into sixteen 25-item groups. Five identical items were added to each form to provide a check on the comparability of the subject groups taking the different forms. The sixteen forms were administered to 1,693 students at Ann Arbor High School. Each student was tested twice, on two different forms of the test. A counter-balanced order was used and the testing sessions were held approximately one month apart. The tests were distributed in sealed envelopes on the morning of each testing, and administered via a public address system. The homeroom teacher served as proctor; in order to reduce cheating to a minimum the sixteen different forms of the test were distributed randomly in each class. The tests were scored and coded right or wrong for each item. Intelligence test scores were made available to us from pupils' records. A special item analysis program was devised[4] in order to select those items which discriminated well between low and high RAT scorers, and simultaneously allowed us to reject items correlating well with intelligence. In addition, we obtained phi coefficients of correlation of item score with total test score and with group intelligence test scores. Summarizing, the following information was available for the evaluation of each item:

1. Per cent passing the item at each RAT quartile, and the upper 10%.
2. Per cent passing the item at each IQ quartile, and the upper 10%.
3. Phi coefficients of correlation of the item score with total RAT score.
4. Phi coefficients of correlation of the item score with intelligence test scores.

Forms 3 and 4 are the results of this item analysis plus two additional revisions. Each revision and its purpose is described in the following discussion of results.

Results and Discussion

Item Analysis. Each of the 400 items was evaluated in terms of its discriminating power, relationship to total test scores, intelligence test scores, and total difficulty level. An item was considered "good" only if it clearly discriminated between the lowest and highest quartiles of the group. The per cent passing the item of the upper 10% group was also considered in this evaluation. Items which correlated more highly with intelligence than with total RAT score were rejected. Two judges independently evaluated the items and only those items on which they agreed were selected for further use. Following the analysis, approximately 180 of the 400 items remained.

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[3] Professor J. E. Milholland assisted with very useful advice at this stage.

[4] Mrs. Kathleen Goode of the University of Michigan Institute for Social Research constructed this program.

Forms C, D, E, F, G. Five 30-item forms were composed of the remaining items. These were again administered at the Ann Arbor High School. By this time, two of the three classes in the first group had been graduated, leaving a substantially different sample. The five forms of the test were administered to 2,126 students in two rounds of testing, each student taking two different forms of the test. A counterbalanced order of presentation was used. Other data were obtained from pupils' records. The results of this testing were analyzed for internal and alternate form reliabilities using existing computer programs.

Table 3 summarizes the findings of this administration. The tests were found to be overly difficult, as can be seen from this table. College prep pupils were able to do an average of less than one-third of the items, with a mean score of only 9.89. The highest scoring subgroup was 12th grade science majors ($M = 13.65$), but even this bright and probably relatively creative group was not able to pass as many as 50% of the items on any of the five forms. In addition, while the level of internal reliability was quite satisfactory, this was probably an artifact of the extremely narrow range of scores. The tests were revised by including easier items in an effort to solve this problem.

Forms J, K, L, M, N. These were the easier versions of the first five forms. These forms were administered to the student body at the Seaholm High School in Birmingham, Michigan ($N = 1,405$), in two consecutive rounds of testing. This is a school where approximately 70% of the student body had gone to college in the previous year. Each pupil took two different forms of the test in counterbalanced order. The results are summarized in Table 4. Inspection will reveal that the average difficulty level was raised as predicted for all forms of the test, with Form M somewhat more difficult than the other four. Comparison with the college prep group at Ann Arbor High School is in order, and an increase approximately equivalent to an average of one standard deviation was obtained. There is no doubt that these forms were easier and now suitable for use with a high school group.

Forms 3 and 4. A further refinement was undertaken in order to improve test reliability. Each item was re-evaluated for item-test correlation. In addition, the consistency of an item's difficulty level on the different high school samples was examined. Those items which varied greatly (> 15% difference in number of people passing the item from one group to the next) were eliminated. In addition, any

TABLE 3

HIGH SCHOOL FORMS C, D, E, F, G
MEAN SCORES, STANDARD DEVIATION, AND RANGE OF SCORES
ANN ARBOR HIGH SCHOOL
N = 1,693

Forms	Total group	Grades			Sex	
		10	11	12	M	F
BAT C						
Mean	8.93	8.87	8.47	9.70	8.56	9.40
S.D.	4.89	4.72	4.60	5.08	5.00	4.64
Range	0-22	0-20	0-22	0-20	0-22	0-20
N	391	143	129	113	194	190
BAT D						
Mean	8.54	7.52	8.08	10.42	7.61	9.50
S.D.	4.58	4.52	4.52	4.56	4.88	4.31
Range	0-21	0-19	0-21	0-19	0-21	1-20
N	389	145	132	111	196	190
BAT E						
Mean	8.91	7.63	8.58	11.01	8.61	9.20
S.D.	4.89	5.10	4.48	5.07	4.96	4.83
Range	0-23	0-19	0-19	0-23	0-21	0-23
N	385	145	124	110	188	184
BAT F						
Mean	8.45	7.52	7.98	10.37	7.90	8.96
S.D.	4.47	4.09	4.57	4.53	4.67	4.32
Range	0-24	0-19	0-24	0-20	0-21	0-24
N	373	149	125	98	188	184
BAT G						
Mean	8.67	7.86	7.76	10.81	8.03	9.40
S.D.	4.47	4.28	4.09	5.10	4.36	4.56
Range	0-21	0-17	0-17	0-21	0-18	0-21
N	381	148	120	109	193	183

TABLE 4

HIGH SCHOOL FORMS J, K, L, M, N
MEAN SCORES, STANDARD DEVIATIONS AND RANGE OF SCORES
SEAHOLM HIGH SCHOOL, BIRMINGHAM, MICHIGAN
N = 1,405

Forms	Total group	Grades			Sex	
		10	11	12	M	F
RAT J						
Mean	15.06	15.10	14.55	15.71	15.12	15.03
S.D.	4.43	3.90	4.60	4.60	4.70	4.30
Range	2-24	2-24	3-24	2-23	2-23	2-24
N	287	118	92	77	156	127
RAT K						
Mean	14.11	13.78	14.04	14.71	14.19	14.04
S.D.	3.87	3.80	3.60	4.20	4.02	3.70
Range	1-23	3-23	4-21	1-21	1-23	1-22
N	275	111	92	72	144	127
RAT L						
Mean	14.53	14.19	14.36	15.21	14.58	14.45
S.D.	4.59	4.30	4.80	5.00	4.50	4.90
Range	1-24	1-22	3-24	3-24	3-24	1-24
N	276	107	94	75	135	140
RAT M						
Mean	12.30	11.62	12.64	12.85	12.05	12.49
S.D.	3.85	4.30	4.30	4.90	4.80	4.40
Range	0-23	0-20	0-21	1-23	0-22	0-23
N	275	107	94	74	131	143
RAT N						
Mean	14.41	13.46	14.36	15.83	13.70	15.16
S.D.	4.93	4.90	5.00	4.90	5.00	4.74
Range	2-24	2-22	3-24	5-23	2-26	4-26
N	290	120	93	77	151	138

item having a single wrong answer given by more than 30% of the group, or a commonly given plausible answer was also eliminated. The latter procedure was carried out by two independent judges. The remaining items were graphed in a scatter diagram with item-test correlation (from initial item selection sample) on the ordinate, and per cent passing item (average for all high school samples) on the abscissa.[5] Forty pairs falling in a close spatial relationship on this graph were selected and arranged in order of item difficulty for the two final forms of the test. The tests were lengthened to include forty items to further improve reliability (Guilford, 1956). In summary, these two forms have the following characteristics.

1. Each item has good discriminating power with respect to total RAT score on basis of percentage passing at each quartile level.
2. Each item is consistent across several high school samples with respect to difficulty level.
3. The items do not have commonly given wrong answers. In several cases wrong answers were commonly given by some high scorers and we felt that this was obfuscating the true discriminating power of the items.
4. The items on the two forms are matched by pairs for both level of difficulty and item total test score correlation.
5. The average difficulty level for each form is approximately 50%.
6. The forms are lengthened to forty items.

All of these factors should enhance the internal and alternate form reliability of Forms 3 and 4. The data currently available on Form 3 are shown in Tables 5 and 6. The internal reliability of Form 3 has been improved as can be seen. An alternate form reliability study is being planned. This will also provide us with some normative data on Form 4. These two forms of the test can be machine scored. The specially designed IBM answer sheet and instructions are in the Appendix.

Two further correlations on the group tested with Form 3 are of interest. The Wechsler Intelligence Scale for Children (WISC) scores were available. A Pearson product moment correlation was performed. The correlation of this test and RAT was .55 ($N = 269$, $\bar{M}$ RAT = 17.9, $\sigma = 7.1$; $\bar{M}$ WISC = 120.6, $\sigma = 15.5$). Similarly, the relationship between RAT and the SRA test of Primary Mental Abilities, a group intelligence test, was found to be .59 ($N = 260$, $\bar{M}$ RAT = 17.9, $\sigma = 7.1$; $\bar{M}$ PMA = 118.6, $\sigma = 12.4$). This result is in general agreement with other findings on the relationship of RAT performance and intelligence, where the tests

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[5] Method follows Gulliksen (1950), pp. 208-210.

TABLE 5

HIGH SCHOOL FORM 3
MEAN SCORES, STANDARD DEVIATIONS,
SPEARMAN-BROWN ODD-EVEN CORRELATIONS
AND STANDARD ERROR OF MEASUREMENT
UNIVERSITY OF MICHIGAN JUNIOR AND SENIOR HIGH SCHOOL
(N = 316)

Grade	N	Mean	SD	Range	r	SEM[a]
7	47	13.27[b]	5.47	2-24	.84	2.19
8	48	14.48	5.37	1-28	.76	2.63
9	50	17.96	6.31	3-26	.87	2.27
10	55	18.21	7.04	3-34	.84	2.82
11	56	22.82	6.28	4-34	.96	1.26
12	60	20.92	6.27	7-31	.87	2.26

[a] Standard error of measurement, or standard error of obtained scores (Guilford, 1956).

[b] 40-item test.

TABLE 6

HIGH SCHOOL FORM 3
PERCENTILE SCORE EQUIVALENTS
UNIVERSITY OF MICHIGAN JUNIOR AND SENIOR HIGH SCHOOLS
(N = 316)

Percentiles	Total group	Grade 7	8	9	10	11	12
99	35+	24+	28+	31+	36+	34+	35+
95	30	24	24	29	31	32	31
90	29	20	23	26	29	30	28
85	27	19	22	24	26	29	27
80	25	19	20	24	24	28	26
75	24	18	18	23	23	27	25
70	23	17	17	22	22	27	24
65	23	17	17	21	22	26	24
60	22	16	16	21	21	26	24
55	21	15	15	20	19	25	23
50	20	15	14	20	18	25	23
45	18	13	14	19	18	24	23
40	17	12	13	18	17	23	22
35	16	11	13	17	17	22	21
30	15	11	12	16	16	22	20
25	14	11	12	15	14	21	18
20	12	10	11	14	13	19	16
15	11	09	10	11	13	18	14
10	09	05	09	09	09	15	12
05	06	03	07	06	06	10	09
01	03	02	01	03	03	04	07
N =	316	47	48	50	55	56	60

have been administered to groups with a wide range of intelligence. This matter is discussed further in the final summary chapter. Further data on RAT and intelligence measures are presented in Table 10.

2.2. Elementary School Form

A group of easy items was selected from our pool of items and administered to the Elementary Schools of the University of Michigan, the Flint, Michigan School System and the Ann Arbor, Michigan School System. These results are presented in Table 7. This form was revised subsequent to these administrations; several of the nondiscriminating items were eliminated. The new 21-item form will be used in new normative studies.

2.3. Form 2: An Alternate to Form 1

Form 2 was constructed as an alternate to Form 1, using a method similar to that described for Forms 3 and 4. In this case 100 items were administered to 200 college undergraduates and submitted to an item analysis; a 30-item form was the result of this procedure. A group of 71 University of Maryland undergraduates who had taken Form 1 also took Form 2. A Spearman-Brown reliability coefficient of .86 was obtained. On the same group a correlation of .81 was obtained between RAT, Form 1 and RAT, Form 2 ($\bar{M}$ RAT, Form 1 = 13.75, S.D. = 4.83, M RAT, Form 2 = 14.86, σ = 4.23).

2.4. Causal Associates Test

The Causal Associates Test (CAT) designed as a measure of creative thinking, also stems from the associative theoretical orientation. Instead of dealing with words as elements for combination, this test makes use of ideas. The subject is provided with three ideas and asked to find a fourth idea related to all three. The nature of the required relationship is specified. We provide the subject with three unusual consequences of an event and ask him to tell us the causal event. This test is a reversal of Guilford's Consequences Test. Guilford asks the subject to suggest as many as possible consequences of an unusual event of which he can think. The CAT provides consequences and asks for the cause. The items which have been used were low probability answers given by groups of individuals responding to the Guilford Consequences Test items. Thus the item components are remote associations to a causal event and in the new situation the subject is asked to relate the three by supplying the event. We feel that the requirements of this task are quite different from that of the Consequences Test since the subject is no longer presented with a free response situation. His response must meet requirements. Ease and objectivity of scoring are other advantages. In a pilot study with fifteen subjects the correlation of CAT and the RAT, Form 1, proved high (Pearson r = .71, N = 15). Further revision of this as yet coarse instrument will be undertaken.

2.5. A Danish Form of the RAT

This form is being developed by the co-investigators and Hans Weltzer at the Psychological Institute, Kommunehospitalet, Copenhagen, Denmark.

Danish word association norms were not available, so we proceeded on an *a priori* basis. The procedure used was essentially similar to the method described above for the development of Forms 3 and 4. One Danish form is being designed for use with 12-14 year olds and another for the college and professional level. All the items were written by Mr. Weltzer and then administered to school children in the 6th and 7th grades. The results were then analyzed once. A final version of one form of the test will be constructed during the coming year and used in further research by Mr. Weltzer. Professor Kaare Svalastoga of the University of Copenhagen is using the test as a measure of creativity in a sample of 10,000 Danish boys.

TABLE 7

ELEMENTARY LEVEL FORM[a]
MEANS, STANDARD DEVIATIONS, RANGES

School	Grade	N	M	SD	Range of scores
University of Michigan Elementary School	4	19	7.10	3.90	1-17
	6	25	7.10	4.00	0-13
	8	46	12.22	4.80	3-19
Ann Arbor, Michigan Public Schools	4 & 6[b]	76	10.79	3.98	2-17
Flint, Michigan Public Schools	3	110	5.18	3.90	1-18
	5	60	9.77	4.90	0-19
Girls	3 & 5	84	7.27	4.85	1-19
Boys	3 & 5	86	6.45	4.92	0-16

[a] Unrevised 25-item form was used.

[b] No breakdown available.

CHAPTER 3

THE VALIDITY OF THE REMOTE ASSOCIATES TEST

The RAT, as noted above, is an operational statement of a theory of creative thinking. Consequently, evidence pertaining to tests of the theory reflects on the validity of the RAT. The test itself was used a number of times as a criterion of creativity in research on the theory. Such theory testing provides indirect evidence in the sense of the concept of construct validity (Cronbach and Meehl, 1955). That is, the meaning of RAT performance is elaborated in terms of its relationship to motivational, personality, cognitive and environmental variables as predicted from the theory. The studies presented in Part III are of this nature. The correlation of the test with various other measures also reflects on its construct validity; Table 10 in this chapter measures a resumé of such correlates.

The third type of validity study conducted on the RAT is of a predictive nature, i.e., studies in which the test is correlated with a criterion of creativity. Some early work of this nature was reported in Part I. The study described in Section 3.1 of this chapter describes another criterion validity study.

3.1. A Criterion Validity Study of Research Creativity in Psychology Graduate Students

With respect to criterion research in the area of creativity, the nature of the criterion is all important in the construction of a predictive instrument. If it is not possible to obtain a relevant reliable measure of this particular class of behavior then it is obviously not possible to begin such a research program. The problem of the choice of a criterion of creativity is a complex one and has been discussed at length (see McPherson in Taylor and Barron, ed., 1963). Two types of criteria which have been used are ratings of individuals and ratings of their productivity. Both types of ratings have characteristic drawbacks. The rating of the creativity of an individual by his supervisor in a laboratory setting, for example, will be influenced by "irrelevant" characteristics of the ratee, the rater, or the setting. The use of productivity level as a criterion also has its pitfalls. In the case of number of patented inventions, for example, it is obvious that these may vary greatly in quality; this factor is difficult to take into account.

The same critique applies of course to counting published papers. Obviously, some scientists may spend their time producing many patentable but nevertheless relatively uncreative products, while others work for many years on one major problem in a very creative manner and with very creative results. Problems inherent in the choice of a criterion of creativity notwithstanding, we chose to conduct such a study, using as a criterion a modification of a scale developed by Taylor (1957) in the course of his work on scientific creativity and productivity.

The purpose of this study was to assess the relationship of Remote Associates Test performance in psychology graduate students to ratings of their research creativity by their research advisors.

Method

Creativity Rating Scale (CRS). For our own work, 24 of the items on Taylor's Thurstone-type scale were reworded so as to make them suitable for the rating of graduate students.[1] The scale values used are identical to those obtained by Taylor. The scales were distributed to research advisors who were asked to rate research advisees. At the universities involved, students are required to work in a research apprenticeship relation with a member of the faculty. Students and advisors are more or less free to choose each other.

The RAT was administered to graduate students entering the Psychology Department at the University of Michigan in 1959 and again in 1960; a group of Northwestern University graduate students was also tested. This gave us a total of 81 Michigan and Northwestern students. At the time of the ratings, 23 of these students had terminated their graduate education and 15 others had not worked intensively enough with any one research advisor to be rated in a reliable manner. CRS ratings were obtained on the remaining 43 students. The ratings were gathered between 1 and 2 years after RAT administration and the raters were not aware of the RAT scores achieved by their advisees. Miller Analogy Test (MAT) scores and grade point averages (GPA) were obtained from subjects' records but were not available on the entire group.

Results and Discussion

For comparison purposes, the means, ranges, and standard deviations of the RAT scores of various graduate student subgroups are given in Table 8 together with two undergraduate groups. It can readily be seen that the specially selected group of honors students did better than unselected undergraduates and that the graduates as a whole obtain scores similar to the former group. The characteristics of the group which received ratings appear to be quite similar to those of the graduate student group as a whole.

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[1] The CRS, instructions and its scale values may be found in the Appendix.

TABLE 8

REMOTE ASSOCIATES TEST SCORES OF PSYCHOLOGY GRADUATE AND UNDERGRADUATE STUDENTS

Group	N	M	Range	SD
Psychology graduate students				
Rated	43	19.8	10-27	4.3
Drop-outs	23	20.8	09-28	4.9
Not rated	15	20.0	16-26	3.1
Total	81	20.1	09-28	4.0
Undergraduate students				
Freshmen	312	16.3	00-28	5.2
Psychology honors	23	20.0	11-28	4.2

The average CRS scores ranged from 18.0 to 56.2 with a mean of 40.7. The internal reliability of the CRS was checked in the following manner. The items were arranged in order of their scale values. These were then divided into odd and even halves and two separate CRS values were computed for each individual. The Spearman-Brown reliability coefficient obtained was .93.

The correlations which were obtained between the various measures are presented in Table 9. We should note that the mean MAT score of this group was 71.1 with a standard deviation of 12.12. The norm group mean was 65.8 with a standard deviation of 13.5 (Miller, 1960). The effect of this restriction of the distribution was evaluated by a correction of the correlation of the MAT and RAT (Guilford, 1956). The correlation of the two tests was thus raised to .44. This indicates that the distribution of the MAT scores in our group is not different enough from those of the original norm group to have an important effect on the correlations reported here.

The correlation of greatest interest from our point of view is, of course, that of the RAT and the CRS. It is evidently possible to predict judgments of graduate student research performance from these test

TABLE 9

MATRIX OF INTERCORRELATIONS OF
RATING SCALE AND TEST SCORES

Measure	RAT	GPA	MAT
CRS			
r	.55**	.06	-.08
N	43	16	24
RAT			
r		-.11	.41*
N		26	25
GPA			
r			-.03
N			.25

$^{*}p < .025$. $^{**}p < .005$.

scores. This particular type of creativity rating was not significantly related to MAT scores or to GPA. This property of the test may recommend it for use in selction of individuals in those instances where research creativity such as is measured by the CRS is a desired trait.

Of course, the reliability and meaningfulness of a rating scale of this type is directly related to the raters' ability to make the required judgments. In our study the students' work was quite well known to the raters and the judgments were perhaps less biased by a halo effect emanating from grades or other test scores. We were perhaps also fortunate in having a group of relatively creative raters.

3.2. Correlation of the Remote Associate Test with Other Measures

Table 10 lists groups of selected measures which have been correlated with performance on the RAT. The reader should note that different forms of the RAT are represented in these correlations (this is indicated in the third column). The table also presents a description of the subject population, the number of subjects, the correlation coefficient, and mean scores and standard deviations for both measures. The latter two measures were unavailable in several instances. These data are discussed in the general interpretative chapter closing this report.

TABLE 10

CORRELATION OF THE REMOTE ASSOCIATES TEST AND OTHER MEASURES

Measure	Group	RAT form	N	r	Other Test Mn	Other Test SD	RAT Mn	RAT SD
A. Intelligence tests								
Lorge-Thorndike	Birmingham, Michigan High School--Junior Class							
Verbal		3^a	106	.41	126.95	13.54	52.48^b	8.77
Quantitative		3^a	106	.34	118.98	10.15	52.48	8.77
Total		3^a	106	.43	123.26	10.39	52.48	8.77
Wechsler Intelligence Scale for Children--Total Score	University of Michigan School (grades 7-12)	3	269	.55	120.60	15.45	17.90	7.07
SRA Intelligence Test	University of Michigan School (grades 7-12)	3	260	.59	118.60	12.37	17.90	7.10
Scholastic Aptitude Test	Harvard Freshman Class (entering 1960)							
Verbal		1	234	.34	667.14	59.26	18.12	4.80
Math.		1	234	.19	689.23	71.34	18.12	4.80
B. Achievement tests								
Iowa Tests of Educational Development	Birmingham, Michigan High School--Junior Class							
Vocabulary		3^a	106	.40	85.43	13.48	52.48^b	8.77
Quantitative		3^a	106	.24	87.92	13.88	52.48	8.77
Total Score		3^a	106	.38	87.28	12.46	52.48	8.77

TABLE 10--(CONTINUED)

Measure	Group	RAT form	N	r	Other Test Mn	Other Test SD	RAT Mn	RAT SD
C. Special ability tests								
Miller Analogy Test	Psychology Graduate Students	1	25	.41	71.10	12.12	20.10	4.00
Doppelt Mathematical Ability Test	Psychology Graduate Students	1	21	-.42	33.70	8.40	22.80	3.30
Terman Concept Mastery Test	IPAR architects							
Total Score		1^a	40	.40	113.20	37.70	127.42	59.32
Guilford-Zimmerman Verbal Comprehension Test	IBM engineers & scientists	1	39	.40	42.79	10.75	17.38	5.54
E.T.S. Inductive Reasoning Test	IBM engineers & scientists	1	39	.43	10.83	4.87	17.38	5.54
Minnesota Engineering Analogies Test	IBM engineers & scientists	1	39	.40	31.59	8.70	17.38	5.54
D. College grades								
Self-ratings of grades	IPAR architects	1	40	-.34	Not available			
Grade point average	Psychology graduate students	1	26	-.11	6.85	0.95	19.12	4.37
Grade point average	Undergraduate engineering students: MIT	1	74	-.27	Not available			

TABLE 10--(CONTINUED)

Measure	Group	RAT form	N	r	Other Test Mn	Other Test SD	RAT Mn	RAT SD
E. Interest and attitude measures								
Strong Vocational Interest Blank (SVIB)	IPAR architects							
Psychologist		1^a	40	.45	41.75	7.37	127.42	59.32
President, Manufacturing Concern		1^a	40	-.40	42.77	8.25	127.42	59.32
Production Manager		1^a	40	-.32	27.38	4.48	127.42	59.32
VA Clinical Psychologist		1^a	40	.32	29.32	7.17	127.42	59.32
SITUS dimension Profile Key--Manufacturing		1^a	40	-.49	35.11	4.93	127.42	59.32
SVIB	Harvard Freshman Class (entering 1960)							
Psychologist		1	234	.31	4.46	1.60	18.12	4.83
Musician		1	234	.25	4.53	1.45	18.12	4.83
Pharmacist		1	234	-.18	2.22	1.13	18.12	4.83
Crutchfield Conformity Task	IPAR architects	1^a	40	-.31	14.51	4.57	127.42	59.32
F-Scale	Harvard Freshman Class (entering 1960)	1	234	-.19	32.92	8.13	18.12	4.83
IPAR Originality Scale	IPAR architects	1^a	40	-.31	Not available			

TABLE 10--(CONTINUED)

Measure	Group	RAT form	N	r	Other Test		RAT	
					Mn	SD	Mn	SD
F. Associative measures								
Commonality (WAT)	U. of Mich. Graduate students	1	48	-.27	13.88	6.62	19.67	5.52
Recall	U. of Mich. Graduate students	1	48	.52	12.60	3.60	19.67	5.52
Intrusions as % of recall	U. of Mich. Graduate students	1	48	-.43	6.90	3.50	19.67	5.52
G. Problem solving and creative thinking								
Gottschaldt Hidden Figures	Birmingham, Michigan High School--Junior Class (Mn. IQ = 123)	3[a]	106	.23	22.41	5.46	52.48[b]	8.77
Guilford Camouflaged Words	"	3[a]	106	.52	7.43	3.84	52.48	8.77
Guilford Gestalt Transformation	"	3[a]	106	.36	11.98	2.97	52.48	8.77
Anagrams--No. of four letter words made from word "generation"	U. of Mich. undergraduates							
a. Quantity		1	40	.44	Not available			
b. Originality		1	40	.37	Not available			
Test of Critical Thinking	Harvard Freshman Class (entering 1960)	1	234	.25	43.88	4.51	18.12	4.83
Causal Associates Test	U. of Mich. undergraduates	1	15	.71	Not available			

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[a] Early version of RAT used.

[b] Standard scores.

PART III

RESEARCH ON ASSOCIATIVE THEORY

INTRODUCTION

The study of creativity requires consideration of an array of variables. Genetic, developmental, associative, cognitive, social, motivational and situational determinants may all influence the creative process in varying degrees.

The theoretical structure which has guided this research is basically an associative theory of thinking. However, by extension this theory has implications for this "array of variables." An important aim of this project was the probing of each of these areas to explore their accessibility to this approach. Accompanying these exploratory probes has been a continuing program of research on associative behavior and supporting studies developing new techniques and experimental procedures. In this section we shall present a series of experimental investigations. Each of these uses associative theory as a point of departure and explores the implication of the theory in a different area.

The first three papers directly test hypotheses concerning the associative behavior of the creative individual and an associative interpretation of the phenomenon of incubation in creative thinking.

The second pair of papers report experiments aimed at assessing the role of needs and conflicts in creative thinking. The first questions why the creative individual goes to the trouble of behaving creatively when conforming behavior is apparently so much easier and more likely to be rewarded. It suggests that he is pushed to this behavior by a positive drive for novel associative stimulation. The second study (Chapter 5) gauges the effect of personal conflict ("negative" drive) on creative thinking. The results suggest that personal conflict only effects creative thinking which is working with material closely related to the conflict. Further, the effect is complex; it facilitates performance for certain types of problems, and inhibits performance for others.

Chapter 6 is a study of child rearing determinants of creative ability. While the results do not suggest that there are vast differences in the manner in which the highly creative individuals have been raised, certain subtle variables are identified and discussed. Chapter 7 reports a study of creativity in scientists.

The final three chapters in this section are reports of studies which developed methods and investigated the role of associative processes in learning.

CHAPTER 1

CONTINUAL ASSOCIATION AS A FUNCTION OF LEVEL OF CREATIVITY AND TYPE OF VERBAL STIMULUS[1]

In this study variations in continual word association behavior as a function of the level of creativity of the associator and the characteristics of verbal stimulus materials were observed. Continual word association refers to a situation in which a subject responds continually with words to one particular stimulus for a given amount of time. In the context of the associative theory of creative thinking, this technique is of value in gathering information on the thought process of the creative individual.

Research on continual associations. Using a variety of stimuli, Mandler and Parnes (1957) found wide but consistent differences between individuals in number of associative responses. Bousfield and Sedgwick (1944) asked subjects to give all of their associations to category names such as makes of automobiles, or wild animals, allowing as much time as needed to exhaust their repertoire. They observed wide differences in number of associations given as a function of type of category, as well as great inter-individual variation.

Much of the research on factors influencing continual verbal association has been concerned with the nature of the stimulus material used. Cofer and Shevitz (1952) found that words which occur with high frequency in the language elicit more responses than do low frequency words and that nouns elicit more responses than adjectives. Lambert (1955) also found that nouns, particularly concrete nouns, elicit more responses than do adjectives.

Creative thinking and continual association. It will be recalled that one of the predictions of this interpretation of creative thought is that sheer number of associations to the elements of a problem is directly related to the probability of reaching a creative solution. This suggests the hypothesis that highly creative individuals will respond with a greater number of associations to a stimulus than less creative individuals. In the present study we examined this relationship by observing the associative behavior of high, medium and low scorers on the RAT. In addition we studied the effect of three characteristics of verbal stimulus materials upon number of associations. These were form-class, Thorndike-Lorge (1944) frequency and associative hierarchy.

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[1] C. C. Jung assisted in preparing the materials and gathering the data for this study.

Associative hierarchy of a particular word is defined by group word association norms (Russell and Jenkins, 1952; Deese,1962). A word with a *steep* associative hierarchy elicits one dominant association and many associations of low response strength, while words with *flat* associative hierarchies do not elicit any dominant responses. When all the responses for a flat hierarchy word are ranked in terms of response frequency, the transition in frequency from response to response has a flat slope.

In summary, on the basis of theory and previous research we predict that (1) individuals with high RAT scores will show a greater quantity of continual associations than will low RAT scorers and a medium RAT group will fall between the two. (2) Nouns will elicit more responses than adjectives. (3) Words which occur more frequently in the language will elicit more responses than words which occur at low frequency in the language. (4) "Flat hierarchy" words will elicit more responses than "steep hierarchy" words.

Method

Subjects. Forty-eight subjects were chosen from the extremes and middle of a group of 289 University of Michigan junior and senior male students who had taken the RAT approximately four months prior to the onset of the study. They were equally divided into high (HC), medium (MC), and low (LC) creativity groups on the basis of their RAT scores. An attempt was made to equate the groups for ACE percentiles in order to control for the possible relationship of intelligence to quantity of continual association. Table 11 summarizes the characteristics of each group with respect to the two measures.

TABLE 11

SCORES ON THE REMOTE ASSOCIATES TEST AND ACE
FOR EACH OF THE EXPERIMENTAL GROUPS

Creativity group	N	Mean RAT score	RAT range	Mean ACE score	ACE range
Low	16	8.06	1-12	52.40	24-91
Medium	16	16.69	16-18	60.00	28-90
High	16	24.19	22-30	60.37	27-95

Materials. The verbal materials were 32 words which were chosen from two available sets of recently gathered Kent-Rosanoff (K-R) norms (Russell and Jenkins, 1952; Deese, 1962). In a factorial design half of these words were nouns and half adjectives; half had flat associative hierarchies, and half had steep associative hierarchies; half were high in frequency of occurrence in the language, and half were low in frequency of occurrence in the language (Thorndike-Lorge, 1944). The high frequency words were AA in word count, while the low frequency words ranged from 7-48 in the word count. Table 12 lists the 32 words according to their characteristics. The RAT, Form 1 was used to select subjects.

TABLE 12

LIST OF STIMULUS WORDS USED
FOR EACH CATEGORY

High Frequency		Low Frequency	
Noun	Adjective	Noun	Adjective
	Flat Associative Hierarchy		
Foot	Blue	Alley	Dull
Music	Nice	Sofa	Colorful
River	Beautiful	Barn	Shrill
Bag	Yellow	Beef	Harsh
	Steep Associative Hierarchy		
Table	Long	Wrath	Shallow
Butter	Heavy	Devotion	Thirsty
Dream	Dark	Scissors	Homely
Salt	Soft	Eagle	Sour

Procedure. Each of the 32 stimulus words was typed on a 3x5 card and administered individually in counter-balanced order controlling for word category. Two sample words introduced the series bringing the total number of stimulus words to 34. Each subject in a group received a different sequence of stimuli which was repeated in each of the creativity groups. The subject was seated facing the corner of a room and the stimulus card was presented on a stand in front of him. He was instructed to give as many associations as he could to the word shown on the card, to fix his attention to it and not to associate to any other word. He was also instructed to punch a telegraph key which had been placed in front of him, each time he said a word. The key was attached to a cumulative recorder which gave a graphic picture of the subject's responses as a function of time. The time allowed for associating to each word was two minutes. All the verbal responses were tape-recorded and subsequently transcribed.

Results

The data are presented in two ways, an analysis of the average number of responses given in the entire two-minute period, and an analysis of the speed of association.

Response Frequency. Figure 2 summarizes the response frequency data for each of the stimulus variables for the three groups. The HC, MC, and LC groups arranged themselves in descending order of associative response frequency in every case. The significance of these results was evaluated by an analysis of variance which is presented in Table 13. Each of the main effect variables were significant. Level of creativity related directly to response frequency. Flat hierarchy words elicited a greater number of responses than steep hierarchy words; high frequency words were accorded more responses than low frequency words; nouns elicited more responses than adjectives. There was no significant interaction between any of the stimulus characteristics and level of RAT performance.

The significant interaction between associative hierarchy and form class deserves some further comment. The mean number of responses given to flat and steep adjectives, respectively, was 14.69 and 14.23. Adjectiveness does not seem to be affected by the variable of associative hierarchy. On the other hand, there was a marked difference between flat and steep nouns. The mean for flat nouns was 18.22 and for steep nouns, 15.28. Thus, the interaction seems due to the fact that the flat nouns tend to elicit a larger number of responses. These data also disclose that the main-effect superiority of the nouns over the adjectives is largely a function of the number of responses given to the flat nouns. Inspection of the individual words in these categories indicates that three of the eight nouns in the steep group, "wrath," "cream," and "devotion," may be regarded as "abstract" words (see Table 11), while the remainder of the steep nouns are relatively "concrete": table, butter, salt, scissors, eagle. The flat nouns, on the other hand, are all "concrete." The mean number of responses for the "abstract" steep nouns ranged from 9.96 to 13.90 with a group mean of 12.33. The mean for the other five steep nouns was 17.05 with a range of 14.83 to 18.35 responses. This is a finding which parallels Lambert's (1955). The effect seems to be most easily attributable to the accidental inclusion of these three abstract nouns in the steep category.

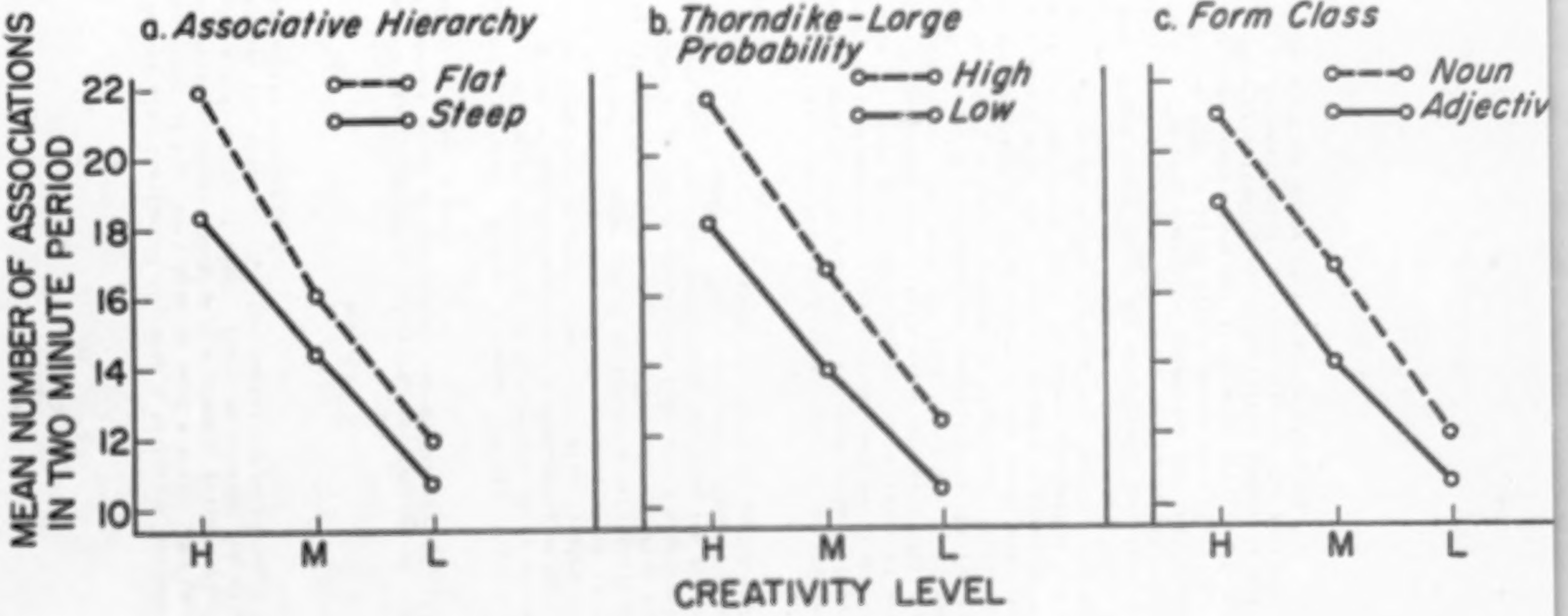

Fig. 2. Response frequency as a function of stimulus associative hierarchy, Thorndike-Lorge probability, form class and creativity.

TABLE 13

ANALYSIS OF VARIANCE OF FREQUENCY OF ASSOCIATIVE RESPONDING AS A FUNCTION OF CREATIVITY AND STIMULUS VARIABLES

	df	Mean square	F
Flat vs. Steep Hierarchy (H)	1	5095.9	11.2*
H x RAT Level (RAT)	2	190.5	< 1.0
H x Form Class (FC)	1	2923.0	6.4*
H x Thorndike-Lorge Count (TL)	1	110.7	< 1.0
H x RAT x FC	2	473.0	< 1.0
H x RAT x TL	2	16.0	< 1.0
H x TL x FC	1	55.0	< 1.0
H x RAT x TL x FC			
Error 1	180	453.9	-
High vs. Low TL	1	9600.0	48.3*
TL x RAT	2	253.6	1.3
TL x FC	1	54.1	< 1.0
TL x RAT x FC	2	374.5	1.9
Error 2	45	198.9	
FC (Noun vs. Adjective)	1	6878.1	64.9*
FC x RAT	2	304.7	2.9
Error 3	45	106.4	
RAT (High vs. Med. vs Low)	2	38838.5	6.4*
Error 4	45	6073.8	

*p < .01.

Note: This treatment is an analysis of variance for a correlated observation design as discussed by Collier (1958) and modified for this study by Professor W. Norman.

2

Speed of Association. Figure 3 presents curves showing the cumulative number of responses as a function of time for each of the creativity levels. The groups' responsiveness across time is positively related to their level of creativity. An analysis of variance of these data revealed a significant interaction between groups and time periods ($F = 4.26$, $p < .01$ for 8 and 180 df).[2] Table 14 reports on the consistency of speed of association across the two-minute association period. The time per association was calculated for the first (pre-median) and second (post-median) halves of each individual's associative output. As can be seen, the three groups separate themselves most markedly in the post-median stage. The HC group is best able to maintain its speed of association. The reliability of the differences among the different scores (column 3, Table 14) were evaluated by an analysis of variance; the groups differ significantly ($F = 6.75$ for 2 and 47 df, $p < .01$).

TABLE 14

PRE- AND POST-MEDIAN TIME PER ASSOCIATION
FOR THE RAT GROUPS

	Pre-median	Post-median	Difference
HC	3.72	9.83	6.11
MC	3.90	13.90	10.00
LC	5.02	20.40	15.38

Discussion and Conclusions

The present results confirm those of previous investigations with respect to the effect of variations in stimuli on the rate of continual associations. As shown before (Cofer and Shevitz, 1952), high frequency words elicit more responses than low frequency words; nouns, especially those which are concrete, elicit more responses than adjectives (Lambert, 1955). A new finding was that the flat associative hierarchy words are more effective response elicitors than the steep associatives hierarchy words, confirming the prediction and adding an additional variable important to the study of continual association. This particular result

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[2] A Lindquist Type I mixed design was used (Lindquist, 1953). The entire analysis is not reported, being in the main a repeat of the findings of the analysis in Table 13.

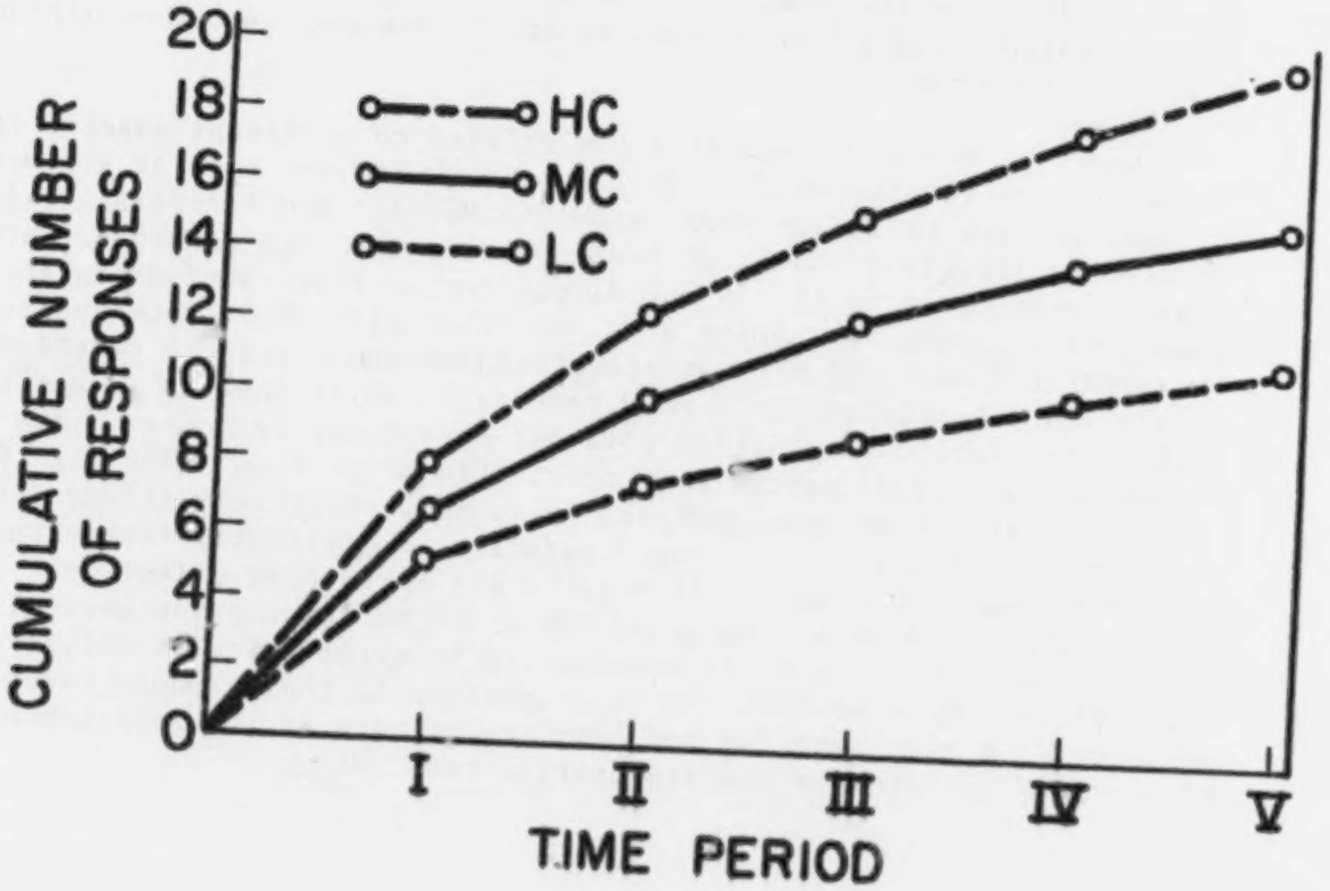

Fig. 3. Cumulative number of responses for fifths of the two-minute time period for the three creativity groups.

is also pertinent to the problem of generalization from single-response, group word association norms to the associative behavior of a single individual. Such generality has been shown in other contexts (Cofer, 1958; Rosen and Russell, 1957; Mednick and Halpern, 1962). Words which elicit many different associations under single-word association instructions, elicit more responses under continual word association conditions. Since subjects in the present study did not give the same word twice as an association to a stimulus word it may be assumed that more different associations occurred.

Level of RAT score was directly related to continual association output. This relationship did not interact with the type of stimulus, a finding which is in agreement with the Mandler and Parnes study (1957). It seems quite clear that high responders remain high responders across a wide range of stimuli. In the discussion of individual differences in associative output in Chapter 1 of the first section of this report, it was predicted that the high creative subject would respond relatively slowly and steadily and emit many responses, while the low creative subject would respond at a higher rate but emit fewer responses. The data of the present study partially support this prediction. The high RAT scorers do give many responses and do so in a relatively steady fashion. Contrary to the prediction, they operate at consistently faster speeds than the other two groups. In view of the increasing differences between groups in later stages of the 2-minute association period, it would be worthwhile to study associative behavior using an unlimited time period. This would allow for depletion of the response reservoir and produce a more detailed and complete picture of the relationship between RAT performance and associative responding.

CHAPTER 2

AN ASSOCIATIVE INTERPRETATION OF VERBAL RELATEDNESS[1]

At least three approaches to the problem of meaning similarity have been proposed in recent literature. Osgood, Suci and Tannenbaum (1957) have emphasized the nonverbal aspects of meaning and meaning similarity, where D expresses the similarity between two words in terms of the distance between their semantic profiles. However, this technique has limitations which Osgood himself realizes. "Many denotatively distinct concepts may occupy the same region of our semantic space, i.e., may have highly similar profiles--'hero' and 'success' and 'nurse' and 'sincere' would be examples" (1957, p. 323). Thus, there must be some aspect of meaning similarity which is not captured by the D score.

In contrast to Osgood's approach, a number of authors have attempted to explain similarity judgments in terms of verbal associative factors. Cofer (1957) and Deese (1962) have proposed measures which vary as a function of the number of identical associations given by a group to both members of a pair of words. Ss gave one association to each of a pair of stimulus words. The measures reflect the per cent of the group's responses which the two stimulus words have in common. There are two limitations to this approach. By restricting Ss to one association many of the private idiosyncratic responses that are usually displayed near the end of an individual's associative hierarchy are lost. This loss must be accompanied by a corresponding reduction in sensitivity. Furthermore, because they are based upon group estimates of similarity, they may not be applicable to problems connected with individual differences in associative structure.

The third approach to the study of meaning similarity attempts to modify Osgood's theory. Flavell and Johnson (1961) asked Ss to give a signal as soon as they perceived a similarity between the members of pairs of words. This latency measure (L) was found to vary inversely with line judgments of similarity. Flavell (1961b) also found a positive correlation between line judgments of similarity and estimates of the probability that the members of pairs of words would "co-occur" in the same spatial setting.

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[1] Co-authored by B. E. Garskof and J. P. Houston, published in Psychol. Rev., 1963, 70, 277-288. The authors wish to express appreciation to Prof. E. Halpern of the University of Michigan, Department of Mathematics for his valuable criticism.

In the development of these two measures, Flavell (1961a) introduces the idea that a full description of the meaning of a word ought to account for the nonverbal representational components associated with the distinguishable attributes of both the referent object and the nonreferent objects present in the physical context of the referent object. He feels that the semantic differential (Osgood, Suci, Tannenbaum, 1957) accounts for that portion of meaning associated with the referent object, but that it does not reflect the representational component connected to the nonreferent objects. It is his contention that L and the co-occurrence measure (C) account for this nonreferent portion of the nonverbal mediational correspondence which D̲ is unable to tap. Either of the measures taken in combination with D̲ should predict semantic similarity better than D̲ alone. His data, however, indicate that this relationship may not exist. In addition, Flavell (1961a) implies that his measures somehow account for verbal associational factors as well as for nonverbal mediational components.

There are a number of difficulties with Flavell's approach. First, it might be argued that Osgood's semantic profiles account for nonreferent representational factors. If this is true the distinction between referent and nonreferent measures becomes inappropriate. Even if we accept for the moment that the distinction is legitimate we have no guarantee that his measures are tapping nonverbal mediational components. It could be argued that L̲ varies directly with the number of existing common associates, and that similarity in meaning varies with the number of common associates. The fewer the number of associates two words have in common, the longer it would taken an individual to chance on one of them. A difficulty with C is that it is dependent upon the degree to which similar things are thought of as co-existing. It will not predict accurately when two elements are similar, but do not co-occur (Indian elephant-African elephant) or co-occur but are not similar (wristwatch-man).

Flavell and Johnson (1961) propose a third measure which is assumed to be equivalent to C and L in terms of its relationship to Osgood's D̲. It was found that the number of similarities perceived between members of a pair of words varied directly with the judged similarity of these words. This technique suffers from the same kind of confusion that surrounds L̲. Although it was designed to estimate the distance between nonverbal representational components connected to the nonreferent objects, its success might be explicable in terms of verbal associative factors. The number of perceived similarities may depend on the number of common associates existing within the hierarchies of the two stimulus words. In summary, then, it seems that in the process of attempting to integrate verbal and nonverbal components of meaning similarity Flavell loses the ability to distinguish between the effects of the two.

An adequate measure of meaning similarity should distinguish between the effects of verbal and nonverbal factors and it should be applicable to the study of individual differences. It should be sensitive to the full range of possible types of similarity and should, if possible, measure basic or underlying processes rather than derivatives of these processes. Furthermore, it may be of more value to develop an explanatory measure which could lead to further insight and study than simply to construct a good predictor.

This paper presents a measure of verbal relatedness which avoids many of the above mentioned difficulties. The premise from which the measure is developed is that the relatedness of two words varies directly with the degree to which the associative hierarchies connected to those two words are identical. This notion finds support in Underwood and Richardson's statement that a relationship exists, "only when one or more common responses are evoked by the different stimuli" (1956, p. 84). The proposed measure is based upon verbal associative processes alone, and does not attempt to account for representational factors which may influence judged relatedness. It is distinct from the techniques employed by Deese (1961) and Cofer (1957) in that it is based upon more than one response per subject.

The measure is designed to account for relatedness rather than similarity. Underwood (1952) has drawn a distinction between the general notion of relatedness and specific kinds of relatedness. He has implied that while similarity is one kind of relationship which may exist between two words, they may be related in a number of other ways. In this sense our measure is quite distinct from the similarity measures mentioned above.

The remainder of the paper will take the following form. First, associative meaning will be defined. Second, the concept of relatedness in terms of the intersect of associative meanings will be developed and a measure of this concept outlined. Third, an experimental investigation of the relationship between the measure and judged relatedness will be reported.

Associative Meaning and Relatedness

Associative Meaning

The associative meaning of a word is defined as the ordered set of associates given by individual $\underline{i}$ at time $\underline{t}$ in response to that word $\underline{u}$. This definition is based upon two considerations. First, the associative meaning of a word for a particular individual may be thought of as all of the associates connected to that word by that individual. Each associate is, in a sense, a "partial meaning" (Noble, 1952). Therefore, each associate must be an integral part of the definition of meaning.

Second, it has been suggested (Underwood and Schulz, 1961) that the associates to a given word have a relatively stable arrangement which reflects their psychological importance and that a behavioral estimate of this arrangement is found in their order of emission. In other words, the order of the obtained set of associates must be part of the meaning of the word; the first emitted associates carry a greater share of meaning than later associates. The following is a formal statement of the definition of associative meaning.

Let $\underline{u}$ denote a stimulus word. We define the associative meaning of $\underline{u}$ as the sequence $A = (a_1, a_2, \ldots, a_j, \ldots, a_m)$ where $a_1 = \underline{u}$ and $a_2, \ldots, a_m$ are associates given to the stimulus word by an individual at a particular time.

It is assumed that the most important component of the meaning of any word is the word itself. Therefore, $a_1 = \underline{u}$ for all $\underline{u}$.

Associative Relatedness

The relatedness of two words ($\underline{u}$ and $\underline{v}$) is defined as a function of the degree to which their respective meanings (A and B) intersect or overlap. The size of the intersect of two meanings is a function of both the number of common associates and the congruence of the rank orders of these elements. It should be noted that when all the elements of A and B are identical, but the orders of emission are different, relatedness is not complete.

The measure of relatedness developed below follows from the definition of associative meaning and is designed to account for the two factors which have been postulated to co-influence degree of relatedness; the number and order of identical associative elements. It is an expression of the ratio of the obtained overlap to the maximum possible overlap. Each step in the derivation of the measure is presented below. Table 15 contains a numerical example of the calculations involved in determining the value of the measure.

Let $\underline{u}$ and $\underline{v}$ be different stimulus words. For a given individual let the associative meaning of $\underline{u}$ be $A = (a_1, a_2, \ldots, a_j, \ldots, a_m)$ where $a_1 = \underline{u}$ and $a_2, \ldots, a_m$ are associates to $\underline{u}$. Define the associative meaning of $\underline{v}$ as $B = (b_1, b_2, \ldots, b_i, \ldots, b_n)$ where $b_1 = \underline{v}$ and $b_2, \ldots, b_n$ are associates to $\underline{v}$. Let $m \leq n$.

Weighting the Associates. To each element a_j in the jth position in A assign the rank $(n - j + 1)^p$ where n is the number of elements in B and p is some fixed number > 0 ($p = 1$ in Table 15). Similarly, to b_i in the ith position in B assign the rank $(n - i + 1)^p$.

This operation assigns weights according to the assumed psychological importance of the elements, the first emitted responses receiving the greatest weight. It also gives equal weight to the first elements in A and B even though the total number of elements in the sequences may differ. The procedure of giving equal weight to the first associates is based upon the assumption that elements in the same position in different hierarchies carry equivalent "amounts" of the meaning of their respective stimulus words.

The Weighting Exponent. The psychological importance of the emitted associates is a function of their order of emission. The weighting exponent p determines the exact nature of this function. In general, the higher the value of p the greater the weight given to first emitted associates. The appropriateness of a particular p depends upon this slope of the associative hierarchy. This slope is controlled by stimulus, individual, and situational factors.

Stimulus words that have dominant associates such as "table-chair" and "light-dark" may be thought of as having steeply sloped hierarchies since their first associates carry a greater proportion of the words' total meanings. For these words a relatively high p should be used. Words having no dominant associates have flat sloped hierarchies since all of the associates carry relatively equal amounts of meaning. Low p values are appropriate for these words.

Individuals may vary in their tendency to produce steep or flat sloped hierarchies. The hierarchies of some people may contain large numbers of approximately co-equal associates while other individuals may possess steeply sloped hierarchies. Thus, the assignment of p may follow the same principle for individuals as it does for stimuli.

Any number of situational variables might bear upon the assignment of the weighting exponent. The work of Smith and Raygor (1956), in which the experimental procedure affected the commonality of the obtained responses, is one example of the possible influence of situational factors.

The appropriate value of p under any given circumstances, will have to be determined empirically or in accordance with some theory.

Assessment of the maximum possible overlap. Let $\underline{A} = [n^p, (n-1)^p, \ldots, 1^p]$ and $\underline{B} = [n^p, (n-1)^p, \ldots, 1^p]$. $\underline{A} \cdot \underline{B} = n^p n^p + (n-1)^p (n-1)^p \ldots + 1^p 1^p$. This product $(\underline{A} \cdot \underline{B})$ represents the intersect which would be obtained if every element in A appeared in B (and B in A) and in the same order. $[n^p - (n-1)]^2$ is an expression of the difference between the product $\underline{A} \cdot \underline{B}$ and the $\underline{A} \cdot \underline{B}$ product in the case where a_1 and b_1 are not identical words.[1] Therefore, $\underline{A} \cdot \underline{B}$ minus $[n^p - (n-1)^p]^2$ represents

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[2] If the pair a_1, b_1 occurred the product $\underline{A} \cdot \underline{B}$ would be $(n^p)(n^p)$ +

the maximum possible overlap in the case where a_1 and b_1, the stimulus words, are different.

Assessment of the obtained overlap. Let $C = (c_1, c_2, \ldots, c_k)$ be obtained by deleting all entries in A which do not occur in B. Define $\bar{A}$ by replacing each element in C by its corresponding rank as an element in A. Similarly, define $\bar{B}$ by replacing each element in C by its corresponding rank as an element in B. The product of these two sequences $(\bar{A} \cdot \bar{B})$ represents the obtained overlap. $\bar{A} \cdot \bar{B} = 0$ if A and B have no common elements. The product will be a maximum if all the elements in A exist in B (and B in A) and in the same order.

The relatedness coefficient (RC).

$$RC = \frac{\bar{A} \cdot \bar{B}}{(\underline{A} \cdot \underline{B}) - [n^p - (n-1)^p]^2}$$

RC is the ratio of the obtained overlap to the maximum possible overlap. It can assume values from 0 to 1.

TABLE 15

COMPUTATION OF A SAMPLE RC FOR THE STIMULUS WORDS EAGLE AND BIRD (p = 1)

Associates to bird	Rank	Associates to bird	Rank
bird	5	eagle	5
wing	4	fly	4
fly	3	bird	3
nest	2	nest	2
		claw	1

A = (bird, wing, fly, nest)

B = (eagle, fly, bird, nest, claw)

$\underline{A} = (5, 4, 3, 2, 1)$

$\underline{B} = (5, 4, 3, 2, 1)$

C = (bird, fly, nest)

$\bar{A} = (5, 3, 2)$

$\bar{B} = (3, 4, 2)$

$$RC = \frac{(5, 3, 2) \cdot (3, 4, 2)}{(5, 4, 3, 2, 1) \cdot (5, 4, 3, 2, 1) - 1} = .57$$

$(n^p)(n^p) + (n-1)^p(n-1)^p + \sum_{k=1}^{n-2} k^{2p}$. If every pair but the pair a_1, b_1 occurred the product $\underline{A} \cdot \underline{B}$ would be $n^p(n-1)^p + (n-1)^p n^p + \sum_{k=1}^{n-2} k^{2p}$. The difference between these two expressions is

$n^p\, [n^p - (n-1)^p] - (n-1)^1\, [n^p - (n-1)^p] = [n^p - (n-1)^p]^2$.

Experiment I

This experiment was designed as a test of the validity of the RC measure. It was hypothesized that RC values based upon individual associative hierarchies would correlate positively with individual judgments of relatedness. Ss associated to each member of 24 pairs of nouns. RC was computed for each of these pairs and correlated with subjective judgments of the relatedness of the same pairs.

Method

Subjects

Ss were twenty University of Michigan undergraduates enrolled in psychology courses. Participation in the experiment was a course requirement.

Materials

Word Pairs. The authors were interested in obtaining a series of pairs that spread over the "relatedness continuum" so that the effectiveness of RC could be tested against varying degrees of relatedness. Twenty-four pairs of nouns were chosen by the following technique. Eight highly related pairs were chosen from Roget's Thesaurus (1942) by pairing randomly chosen nouns with one of their first synonyms. A second less related category was chosen by randomly picking a noun from the Thesaurus, choosing one of its synonyms and then looking up one of this synonym's synonyms and pairing it with the original noun. Eight pairs assumed to be minimally related were chosen and matched by a random procedure.

TABLE 16

24 WORD PAIRS ARRANGED BY THESAURUS DETERMINED RELATEDNESS GROUPS

High related	Medium related	Low related
House-Home	Boat-Vessel	Glove-People
Ocean-Sea	Night-Shadow	Summer-Church
Yolk-Egg	Emblem-Label	Lip-Bacon
Midnight-Dark	Closet-Storehouse	Ash-Gin
Bandit-Thief	Path-Street	Navy-Glass
Lizard-Reptile	Table-Bread	City-Sugar
Restaurant-Food	King-Governor	Jail-Napkin
Morning-Dawn	Lunatic-Fool	Whisker-Prize

The frequency of occurrence of the members of the pairs was controlled through the use of the Thorndike-Lorge Word Frequency Count (1944). Two pairs at each level of relatedness were composed of the following frequencies: high-high, low-low, low-high. The high words were AA words in the Thorndike-Lorge count, low words were A or below.

The Judgment Scales. Each S was presented with a 24-page booklet. On each page, one of the 24 pairs of words was printed above a 5" line with the ends marked 0 and 1. There were no divisions on the line. Each booklet contained all the pairs in a different order.

The Association Materials. The association material consisted of a 48 page booklet. On each of the pages one of the 48 stimulus words was printed 50 times in order to minimize chaining, or the influence of an association upon subsequent responses. A blank space followed each printing of the word. The pages in these booklets were arranged in 4 random orders. Each booklet contained all 48 words.

Procedure

The 20 Ss, tested in a group, were given the association booklet and read the following instructions, "On each of the following pages you will find a stimulus word listed many times. After each word is a blank space. Your task is to associate to the stimulus word. Look at the stimulus word and write in the space provided the word it makes you think of. Continue to associate to the word until you are told to stop. You are not expected to fill in all the blank spaces, but do the best you can."

Ss were given one minute to associate to each stimulus word. When time expired for a particular word E would say "stop," then instruct Ss to turn the page and begin associating again.

After a 5 minute rest period Ss were given the judgment booklets with the instructions printed on the front. E read the following instructions. "On each of the following pages you will find pairs of words. Your task is to judge how related these two words are and to indicate your judgment by placing an 'x' on the line which you will find below each pair of words. For instance, if you felt that two words were fairly unrelated you would place an 'x' somewhere on the 'o' end of the line; if two words seemed to be very related you would place your 'x' somewhere on the '1' end of the line. Try and make the position of your'x' correspond to the degree to which you feel the two words are related."

No time limit was imposed. Ss were allowed to reconsider previously made judgments.

Results

The judgment scores. The judgment score for a pair of words was the per cent of the line delineated by the S's "x" to the nearest sixteenth of an inch. The projection of the intersect of the "x" on the line scale was taken to be the judgment point.

The relatedness coefficient (RC). RC was computed for each Ss associations to each pair of words according to the method described in Table 15. The computational procedure for determining RC involved the calculation of the ratio of the sum of the cross-products of the ranks of the common elements (raised to some power) to the sum of the squares of the ranks of the larger hierarchy. RC was computed for both p = 1 and p = 2.

Comparison of the RC and judgment scores. Rank-order correlations were computed between each Ss RC and judgment scores for the 24 word pairs. Table 17 contains the individual correlations for both values of p. All correlations reached the .01 level of significance.

TABLE 17

RANK ORDER CORRELATIONS BETWEEN S's LINE JUDGMENTS AND RC SCORES FOR TWO VALUES OF p

S	Rho		S	Rho	
	p = 1	p = 2		p = 1	p = 2
1	.90	.94	11	.75	.74
2	.89	.81	12	.75	.77
3	.85	.80	13	.72	.73
4	.85	.83	14	.72	.80
5	.82	.78	15	.74	.69
6	.79	.81	16	.69	.68
7	.79	.80	17	.67	.65
8	.82	.78	18	.65	.71
9	.77	.74	19	.63	.66
10	.80	.76	20	.63	.68

Comparison of the effects of the two p values. The number of correlations falling above and below the median correlation for both weighting exponents were equal, indicating that the two p values did not differentially effect the correlations.

Discussion

The obtained significant correlations support the hypothesis that judged relatedness between two words varies with the size of the overlap of the associative hierarchies connected to those words.

Although correlation does not determine causality, the authors infer that judged relatedness depends upon associative relatedness. If this contention is accurate the obtained results clearly demonstrate the dependency of individual behavior upon individual associative structure.

The lack of a difference between the relative efficacy of the two weighting exponents suggests that the Ss and words employed in the experiment were heterogeneous enough to mask the importance of either value. For instance, if $p = 1$ was the appropriate exponent for half the Ss and $p = 2$ appropriate for the other half then grouping the results of both halves would render the effects of the two values indistinguishable.

Experiment II

This experiment was designed to demonstrate the predictive power of the weighting exponent (p) which may have been masked in Experiment I. Through the manipulation of subject, word or situational variables it should be possible to demonstrate that, in some instances, a p value of 2 yields better correlations than does a value of 1. Although relevant word and situational variables might as easily have been employed a subject variable was investigated in the present study.

According to the theory presented earlier, $p = 2$ might produce better approximations of the correct weighting for individuals whose first emitted associates carried much of the meaning of the stimulus word while $p = 1$ would be appropriate in the case of individuals for whom the first emitted associates were approximately as important as later associates. If Ss could be differentiated in terms of their tendency to attribute more or less importance to the first emitted associates it should be possible to demonstrate the predictive power of p.

As will be recalled the theory of creative thinking suggests that the highly creative individual possesses flat associative hierarchies while the low creative has steep hierarchies. (Flat associative hierarchies are those in which the probability of evocation of a large number of associates are relatively equal. Steep hierarchies are those in which a few associates are extremely probable while others are quite improbable.) The experiment studying continual associative behavior presents evidence that the Remote Associates Test spreads individuals along this steep-flat hierarchy dimension.

The hypothesis is that correlations between RC and judgment scores should be higher for high creatives when p = 1 and that correlations should be higher for low creatives when p = 2. This is based upon the notion that, in the case of an individual with a flat associative hierarchy, a close approximation to the true weighting exponent is represented by p = 1; p = 2, which gives more weight to the first emitted associates, is proposed as the appropriate value in the case of a steep hierarchy individual for whom the first emitted associates carry more of the meaning of the stimulus word.

Method

The Ss were the same 20 undergraduates employed in Experiment I. In addition to the associations obtained in Experiment I, Remote Associates Test scores were obtained for all Ss. The Remote Associates Test (RAT) was administered several months prior to the Experiment I test session.

The Ss were not aware of the connection between the two sessions. On the basis of their RAT scores Ss were divided at the median into high and low creativity groups. The scores of the low creativity group ranged from 7 to 19 with a mean of 13.8. The high creativity group scores ranged from 20 to 28 with a mean of 23.5.

Results and Discussion

The correlations between RC and judgment scores were available from Experiment I for both p values. A count was taken of the number of high creatives whose correlation was higher under the p = 1 condition and the number of low creatives whose correlation was higher under the p = 2 condition. Eight high creatives showed higher RCs when p = 1 while 2 high creatives showed higher RCs when p = 2. Seven low creatives showed higher RCs when p = 2 while 3 low creatives showed higher RCs when p = 1. These frequencies were subjected to Fisher's Exact Test. The obtained probability value of .036 (one tailed) indicates that the creativity group correlations showed differential improvement under the two ranking conditions. These results suggest that 2 is the appropriate p value for low creatives while 1 is more suitable for highly creative Ss.

The results of this experiment imply that the weighting exponent is both meaningful and subject to empirical investigation. With proper consideration of individual, stimulus word and situational variables appropriate weightings should be attainable.

Even though it is possible to define empirically p values which "fit" particular circumstances, it should be remembered that any exponential function is merely an approximation of a function which is probably very complex.

Experiment III

If the hierarchies evoked in one experimental situation were manifestly different from the hierarchies obtained in another session the usefulness of RC would be in question. In order to test the stability of RC the 20 Ss used in Experiment I were asked to participate in a second experimental task. In this session the Ss associated to the same stimulus words under conditions comparable to the first session. It was hypothesized that the RC scores obtained on the 2 different occasions would correlate positively.

A second hypothesis was based upon the finding that high RAT scorers have a greater repertoire of available associates than do low scorers. This suggests that high RAT scorers will produce hierarchies which vary more from situation to situation than do the hierarchies of low RAT Ss. It was hypothesized that the stability of the high RAT scorers would be significantly less than the stability of the low scorers.

Method

The Ss and the association booklets were identical to those employed during Experiment I. On the night following Experiment I Ss again associated to the same 48 stimulus words. The same instructions and procedures were followed with the addition of the following statement read to Ss. "Try to associate to these words as if you had not already done so."

Results and Discussion

For each S the RC scores obtained during the first session were correlated (rank order) with the RC values obtained during the second session ($p = 1$). Table 18 contains these correlations.

Each of the correlations was significant at greater than the .01 level. Ss were split into the same high and low creativity groups that were employed in Experiment II. A count was taken of the number of high creative and low creative Ss falling above and below the median stability correlation. Eight high creative Ss were below and 2 were above the median. This is in contrast to the low creative group, 8 of whom were above and 2 below the median stability correlation. Fisher's Exact Test, when applied to these frequencies, yielded a probability of .014 (one tailed).

TABLE 18

RANK ORDER CORRELATIONS BETWEEN RC VALUES
OBTAINED ON DIFFERENT NIGHTS
FROM CREATIVITY GROUPS

High Creativity		Low Creativity	
S	Rho	S	Rho
4	.85	2	.91
3	.83	14	.89
11	.82	10	.89
15	.80	1	.88
7	.80	13	.87
5	.80	17	.84
9	.79	12	.84
16	.77	6	.84
18	.72	20	.81
8	.72	19	.78

The high positive correlations obtained between the RCs support the hypothesis that RC is a reliable measure. These correlations indicate that the evoked hierarchies are stable enough to justify the use of the first night's samples as representative associative meanings.

Future use of this measure should entail modifications of procedure so that more representative samples of individual hierarchies might be obtained. This may be accomplished by repeated association sessions from which average ranks can be computed. Further, although the instructions and the form of the associating material were designed to discourage chaining, it still occurred. Obviously, such chain associating can only lower correlations as it increases the size of the denominator of RC while it lessens the chance of overlapping associates. Repeated visual presentation or verbal repetition of stimuli by E would further reduce chain associating.

The significant difference between the stability of the RCs of the high and low RAT scorers again demonstrates the importance of individual variables in the consideration of associative relatedness.

CHAPTER 3

INCUBATION OF CREATIVE PERFORMANCE AND SPECIFIC ASSOCIATIVE PRIMING[1]

Creative persons, in describing their work habits, or the process of creative problem solving, have frequently stressed the importance of a time interval following an intensive period of work in facilitating the solution of a perplexing problem. Poincare, the French mathematician, has reported it in his analysis of the process of solving difficult problems (Poincare, 1954). In this connection Helmholtz, in speaking of the attainment of solutions said, "Often they were there in the morning when I awoke . . . but they liked especially to make their appearance while I was taking an easy walk over wooded hills in sunny weather" (Woodworth and Schlosberg, 1954, pp. 838-839). The time interval may vary from a few moments through weeks or months away from the problem and is terminated by the occurrence of the solution. If any thinking about the specific problem is going on during this time it is at least not at the conscious level. Wallas (1926) in his description of the stages of the creative process includes incubation as the stage of the creative process during which the person is not actively thinking about the problem. In several studies of creativity carried out to investigate the validity of Wallas' stages, Patrick (1935) observed and attempted to analyze the process of creative thought. Fifty-five poets were observed at work and also responded to a questionnaire about their work habits. A control group of nonpoets was also studied in the same way. "Stages" of creativity were observed, and of particular interest was the finding that while talking or thinking of other matters, ideas relevant to the writing of the poem would occur. This was considered to be evidence for an incubation period. Similar studies of scientists and painters (Patrick, 1938, 1941) also added evidence to the observation that most creative individuals experience and even intentionally utilize this phenomenon. In summary, incubation of creative performance may be defined as a stage of the process during which no active attempts at solution are being made but which nevertheless results in improvement of performance.

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[1] E. V. Mednick, now at Department of Sociology, Rutgers University, assisted with preparation of materials, data collection and statistical analyses. He is third author of this chapter. It is published in Journal of Abnormal and Social Psychology, 1964, 69, 84-88.

The writers in the area have searched for an explanatory mechanism other than rest per se. Poincare, for example, (1954) regards incubation as the work of the unconscious mind. Woodworth (1934) suggests that it might be the results of overcoming interferences in thought while others have stressed the importance of the change of mental set. Youtz, applying Hull's (1935) approach to problem solving suggests that during incubation when the problem is "apparently out of mind, the problem solver, although unaware of it, was trying out many possible solutions. In trying out solutions the problem solver makes tentative assemblies of habit segments never previously combined. Although we do not know at the present time why the more plausible solutions become conscious, it seems likely that this is what occurs . . ." (Youtz, 1962, p. 197). Attempts at rigorous explanations have, however, been few and tests of particular notions, to our knowledge, nonexistent.

The present study of incubation was conducted in the context of the associative approach to creative thinking. Accordingly, one function of the incubation period would be to introduce new associative elements, i.e., new stimuli, that would serve to facilitate, directly or through mediation, the combination of the crucial associations. These stimuli can be thoughts of extra-person events. In most instances reported, the creator seems to be unaware of the occurrence of the facilitating stimulation. Nevertheless, this view would hold that during incubation such stimulation occurs, resulting in a change in the probabilities of the associations to the elements of the problem of creative production. Such an influence has a close parallel in association research in the work on associative priming. This research (Storms, 1959, Cofer, 1960) has demonstrated the manner in which associative priming (pre-task stimulation) can alter associative probabilities. In the present study we hypothesized that incubation will be enhanced by the occurrence of specific associative priming of the relevant associative elements. Less of an effect will be observed in the absence of such priming. It should be noted that we do recognize the possibility that other mechanisms, such as dissipation of inhibition, or continued testing of new associative combinations are operative during the rest period.

We conducted two experiments which tested the effect of specific priming upon incubation of creative performance.

Method

Materials. The task[2] used in these two experiments was composed of a group of 26 items which had been found to be very difficult on our original high school item analysis sample. These were used as a creative problem-solving task. An example of such an item (passed by 13% of the norm group) is break train battle; the answer is station. Another example is train pony sorrow (passed by 23% of the original group); the answer is express. Twenty-six items ranging in difficulty level from 13% to 25%, with a mean level of 18% were used.

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[2] Remote associate task refers to this group of items used in the present experiment, while Remote Associate Test or RAT refers only to one of the standard test forms.

A second task was designed to provide the specific associative priming required to attain the correct solution to the RAT test. A very simple analogy problem was written for each RAT item answer. Thus in the case of the first example given above, the analogy was T.V. : channel as radio : s________. Since it was essential that the correct response be given, the first letter of the answer was provided. The twenty-six analogies were answered correctly 100% of the time by four preliminary subjects.

Experiment I

Subjects. Thirty summer school students, 17 male and 13 female, all with American English as their native language were the subjects of this study.

Materials. The remote associate items and relevant analogies were the task materials. In addition, four sample and five relatively easy remote associate items were administered first in order to orient the subjects to the task. The 35 items and 26 analogies were typed individually on 3x5 index cards.

Procedure. The procedure was identical for all subjects.

Step I. Remote associate task. The four sample and five easy remote associate items were administered, followed by the 26 difficult items, each item being individually exposed for a maximum of one minute. The 26 difficult items were administered in a random order obtained by shuffling the index cards. The answer and its latency were recorded on specially prepared data sheets.

Step II. Specific associative priming. E selected ten difficult items which the subject had not correctly answered. Five of these were selected for specific priming and five were control items. The E was guided in his choice by the rule that across all subjects each item must appear equally often in the control and priming groups of items. The five appropriate analogies were then individually administered. Every subject answered all analogies correctly.

Step III. Test for incubation. The five primed and five control remote associate items were then readministered in alternating order in the same manner as in Step I. The subjects were encouraged to guess.

Step IV. Interview. The subjects were intensively questioned about their ideas regarding the relationship between the analogy and the remote associate tasks. Not one subject expressed any insight into the nature of the task. In fact, in pilot work with psychology graduate students, only one subject had recognized the purpose of the analogy task.

The four steps were contiguous, with only the several minutes needed for E to select priming items elapsing between Steps I and II.

Several days after the completion of the experiment, 23 of the subjects were contacted and asked to return to take Form I of the RAT.

Results

The mean number of the 31 remote associate items answered correctly was 8.5 ($\sigma = 3.68$); the mean score on the 26 difficult items was 5.60 ($\sigma = 2.68$). To determine whether incubation took place, the scores on the five primed and five control remote associate items of Step III were compared. The mean number answered correctly for the primed items was 0.8, the nonprimed was 0.4 ($t = 1.9$, for 29 df, $p < .05$, one tailed test).[3] Specific priming did appear to facilitate creative problem solving within this particular paradigm. It is interesting to note that the mean score of this group of subjects tested on RAT-I was 17.9, which is close to the average score (17.3) for students in the College of Liberal Arts at the University of Michigan.

Experiment II

The second experiment was conducted as a replication of the first and as an attempt to evaluate the role of the level of creativity, the length of the time interval and the temporal relationship between the tasks. In a 2x2x3 factorial design we studied the effect on creative performance of two degrees of associative priming (some and none), two levels of creativity (as measured by score on the RAT, Form I), and three kinds of time relationships (none, priming before a 24 hour interval, and priming after a 24 hour interval).

Method

Subjects. Subjects for the experiment were selected from introductory psychology classes at the summer school session of the University of Michigan. Form I of the RAT had been administered to these classes some time prior to the onset of the present study. Twenty-four high RAT scorers with a mean score of 22.25 and a range of 19 to 28 were selected for the high creativity group (HC) and 24 low RAT scorers with a mean of 8.21 and scores ranging from 1-12, comprised the low creativity group (LC).

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[3] A T-test for correlated means was used.

Priming. The priming items were selected by the experimenter, in the same manner as they had been for Experiment I. However, since the factorial design provided for a comparison of specific and nonspecific priming in different subjects, only five items for Step III had to be chosen for each individual. Thus, for specific priming, five incorrect items and relevant analogies were used, while for the control condition the analogies were irrelevant to the five items selected for Step III. Items appeared in the priming and control conditions equally often.

Incubation. In the immediate condition, the first remote associate task (Step I), the priming task (Step II), and the test for incubation (Step III) were contiguous, exactly as they had been in Experiment I. In the second condition (pre-24 hour interval) Step II immediately followed Step I, with 24 hours intervening before Step III. In the third condition (post-24 hour interval) both Steps II and III followed the 24 hour interval.

Except for the variations noted above, the materials used and procedure followed were exactly the same as in Experiment I.

Results and Discussion

Table 19 presents the mean number of items answered correctly in Step III under the various experimental conditions. Table 20 presents the analysis of variance of these data. The HC and LC groups differ significantly in the number of correct answers given after incubation without regard to priming.

TABLE 19

MEAN NUMBER OF REMOTE ASSOCIATE ITEMS CORRECT
FOLLOWING INCUBATION

	High Creative		Low Creative	
	Priming	Control	Priming	Control
Immediate	1.50	0.50	0.50	.25
Pre-24 hours	1.50	1.00	0.25	.50
Post-24 hours	1.75	1.00	0.75	.25

TABLE 20

ANALYSIS OF VARIANCE OF DATA
IN TABLE 19

Source	df	MS	F
Creativity Group (A)	1	7.52	12.05**
Priming (B)	1	2.52	4.00*
Time (C)	2	.25	ns.
A x B	1	1.02	ns.
B x C	2	.34	ns.
A x C	2	.08	ns.
A x B x C	2	.08	ns.
Within	36	.63	-

*$p < .05$, one tail test.

**$p < .01$.

Though there was mild improvement in all groups following the interval between the tasks, the primed subjects gave reliably more correct answers after the incubation period than unprimed subjects. The length and placement of the time interval had no differential effect upon performance. This casts some doubt on the notion that dissipation of fatigue or inhibition is involved, since in such a case a direct relationship with length of rest interval would be expected.

With respect to the differences between the groups, the performance increment was greater for the HC group that the LC group in both the priming and control condition. In Experiment I it was seen that the priming effect in the middle range RAT group was an intermediate one. While the creativity-priming interaction was not a significant one, the data nevertheless suggest that this relationship between incubation of creative performance and RAT level should be examined more closely. The HC group showed more of an increment in performance following the interval and also seemed more sensitive to associative priming. A study recently reported by Mendelsohn and Griswold (1964) demonstrated that high RAT scorers use incidental cues in problem solving to a greater extent than do low RAT scorers. If the analogy task in the present study is regarded as a situation in which an incidental cue is provided, then it would be expected that the highly creative person should be more sensitive to the priming than the low creative.

The results are in keeping with the hypothesis that specific associative priming is an effective variable in the incubation of creative performance, and lend support to the general associative theory. The small amount of incubation that did occur in the absence of specific priming has not been explained and needs further study, as does the fact that the high RAT scorers seem to incubate more readily than do the low scorers.

CHAPTER 4

CREATIVITY AND THE NEED FOR NOVELTY[1]

This experiment is an attempt to explore a motivational factor in creative behavior. Specifically, we tested the hypothesis that the highly creative person has a strong need for associative novelty.

Positing a need for associative novelty in the highly creative person certainly seems a banal hypothesis until examined a bit more closely. There has been some considerable effort to assert and demonstrate that the creative individual has a preference for novelty (Barron, 1958; Golovin, 1959; Sprecher, 1959). However, demonstration of preference alone does not establish the existence of a need. There are several ways that the existence of a need as a drive state may be demonstrated. In this experiment we have attempted to satisfy the need and observe whether the consequent reinforcement would increase the probability of emittence of behavior which immediately preceded the reinforcement. Thus if there is a need for novel associative stimulation then supplying such stimulation should reduce the need (just as ingesting of food reduces hunger). If the need is reduced then this should produce reinforcement. To demonstrate the reinforcing properties of novel associative stimuli, a variation of the verbal operant conditioning technique was employed. Each time the subject chose the noun member of a pair of words he was answered with an improbable association to that noun; each time he chose the nonnoun member of a pair, a highly probable association was given. If the improbable, novel association has reinforcing properties the rate of the noun response would be expected to increase. We predicted that highly creative individuals would show the effect of such reinforcement while less creative individuals would not.

Method

Subjects

Subjects were chosen from a pool of University of Michigan undergraduates to whom the RAT had been administered several months prior to the onset of the present study. Thirty high RAT scorers composed the high creative (HC) group, and 30 low RAT scorers composed the low creative (LC) group. Mean HC score was 24.36, with a range of 22-29, and the LC mean score was 12.96, with a range of 4-19.

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[1] John B. Houston, now at the University of California at Los Angeles, is the first author of this chapter also published in the Journal of Abnormal and Social Psychology, 1963, 66, No. 3, 137-141.

Materials

The materials consisted of a series of 180 3" x 5" index cards, on which a pair of words was centered and typed one above the other. All subjects received the series in the same order.

Free Operant Items. The first 40 items in the series of 180 were composed of pairs of nouns and nonnouns matched for frequency of occurrence by the Thorndike-Lorge (1944) lists. Half the nouns were randomly assigned to the top position on the cards. These 40 free operant items were introduced to obtain a baseline preference for choosing nouns. To each of the subject's 40 free operant choices the experimenter responded with its most common associate. Common associates were defined as one of the three associations most frequently given by a group of 25 Michigan undergraduates.

Filler Items. Every ninth card in the series of 180 was printed with a pair of nonnouns. The experimenter always responded with a common associate to the two nonnouns. These 20 filler items, which are disregarded in the results, were introduced in the hope of preventing the subject from gaining insight into the experimental method. These word pairs were chosen in the same manner as the free operant items.

Critical Items. The remaining 120 items were composed of pairs of nouns and nonnouns taken from the Minnesota Kent-Rosanoff norms (Russell and Jenkins, 1954) and from a set of word association norms prepared by Deese (1960 unpublished). Each pair was also matched for frequency of occurrence in the language by the use of the Thorndike-Lorge (1944) lists; half of the nouns were randomly assigned to the top position on the card. The common associations given by the experimenter to these words were the associations given most frequently in the Deese and Kent-Rosanoff norms. Novel associations were defined either as the associations occurring uniquely or not given at all in the norms. (In the latter case the experimenter supplied the association.)

Procedure

The HC and LC groups were each randomly divided into a control and experimental group of 15 subjects each. Table 21 presents the mean and range of RAT scores obtained by the four groups.

All subjects were seen individually; the experimenter read the following instructions:

TABLE 21

MEAN AND RANGE OF RAT SCORES

RAT group	Experimental group		Control group	
	M	Range	M	Range
High	24.66	22-29	24.06	22-27
Low	13.26	4-18	12.66	6-16

> I am going to show you some cards, one at a time. On each card there are two words. I want you to look at both words and say aloud the one you like best. In response to each word you say aloud I will say a word, or give you an association. For example, if I show you a card with the words "pencil" and "telephone" on it and you choose "pencil" I might say "paper." If you said "telephone" I might say "call." So, for each card you will choose one of the two words and say it out loud and I will give you a response word. Pay attention to the words and associations because I shall ask you to do something else later on. Any questions?

The experimenter then presented the 180-card series and recorded the number of nouns chosen by the subject.

Each time a member of the two Experimental groups (HC and LC) chose a noun on one of the 120 critical items, the experimenter responded with a novel association; each time he chose a nonnoun, the experimenter presented a common association. For example, if a pair of words were FATHER and WHITE and an experimental subject chose WHITE the experimenter would say "black." If the subject chose FATHER, the experimenter might respond with "eggbeater." The two Control groups (HC and LC) were given common associations to both nouns and nonnouns. For example, if a Control subject chose FATHER from the above example, the experimenter responded with "mother." Pilot studies indicated that the HC subjects tended to choose the nonnoun before any experimental manipulations were introduced. Just as in T maze research the subject is trained away from his position preference, we attempted to operantly condition the high creatives to choose the nonpreferred noun.

After the completion of the series of 180 cards the experimenter asked the subject to try to recall all the words on the cards. An interview with the subject concerning the intent of the experiment followed the testing session.

Results

The interview following the testing session revealed that none of the subjects had perceived or suspected the intent of the experimenter. The majority of the subjects reported an awareness of the difference between novel and common associations but none were conscious of their contingent relationship to the "nounness" of the stimulus words.

Conditioning Data

For purposes of analysis, the 180 items were divided into four trials of 40 items each. The 20 filler items were disregarded. Figure 4 presents the mean number of nouns chosen per trial by the High Creative-Experimental (HCE) and the Low Creative-Experimental (LCE) groups. Table 22 contains the repeated measurements analysis of variance (Edwards, 1951) by which the HCE and LCE group performances were compared.

Neither of the main effects were significant. The Trials x Creativity interaction was significant at the .001 level. This interaction suggests that the novel associations had a differential effect on the performance of the HCE and LCE groups over trials.

The predictions that the HCE group would show an increase in the number of nouns they chose was supported by a significant correlated _t_ value obtained in comparing the HCE means on Trials 1 and 4 ($t = 2.37$, $df = 14$, $p < .05$). However, while the number of nouns chosen by the HCE group significantly _increased_, the number chosen by the LCE group significantly _decreased_.

TABLE 22

REPEATED MEASUREMENTS ANALYSIS OF VARIANCE
OF HCE AND LCE GROUPS

Source	df	MS	F
Creativity	1	.00	.00
Between subjects in same group	28	46.51	
Total between subjects	29		
Trials	3	7.36	.48
Creativity x Trials	3	96.61	6.44*
Interaction: Pooled subjects x Trials	84	15.27	
Total within subjects	90		

*$p < .001$.

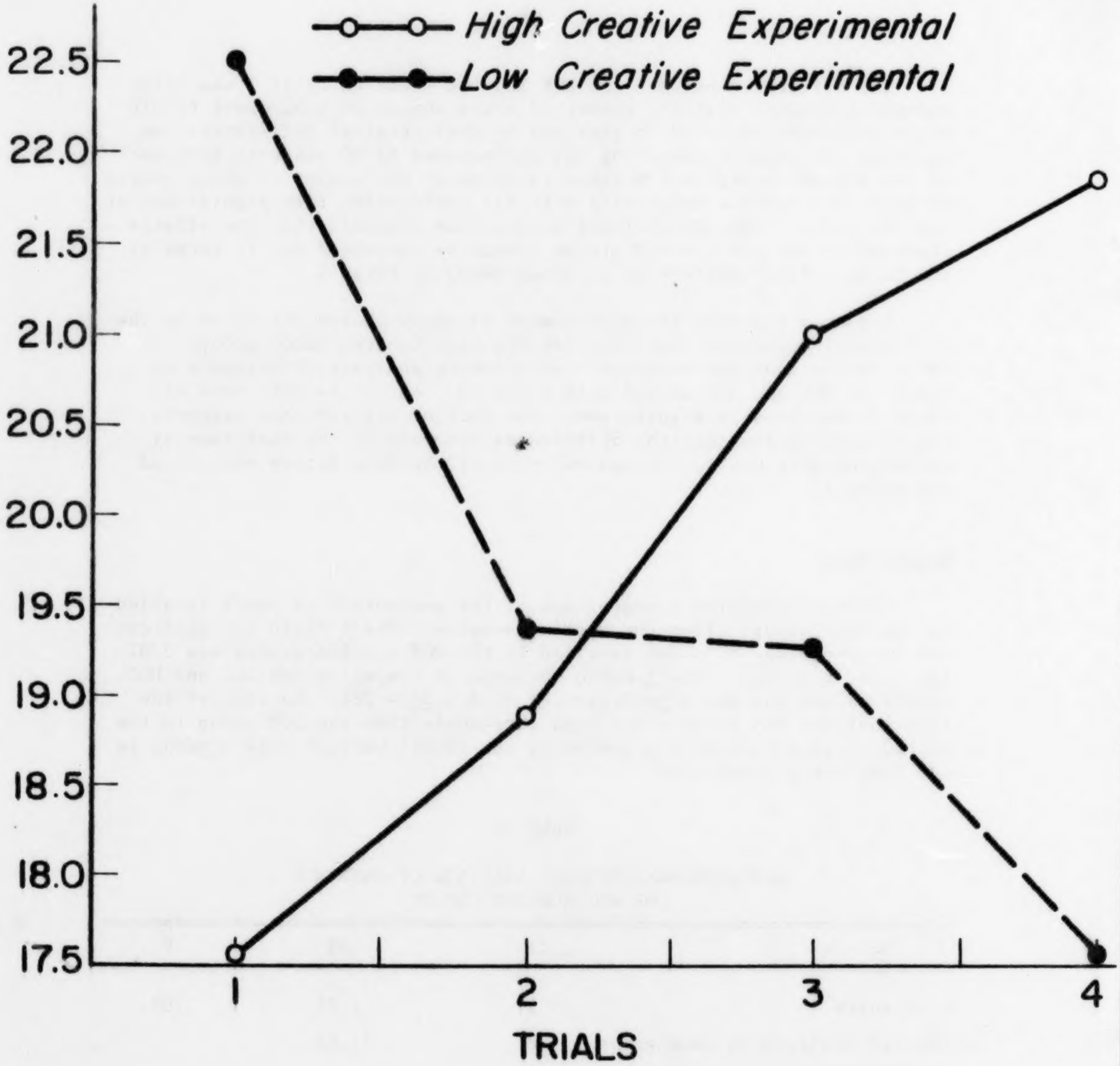

Fig. 4. Mean number of nouns chosen per trial by the HCE and LCE groups.

The difference between the HCE and LCE means on Trial 1 was large enough to suggest that the number of nouns chosen on subsequent trials might have been affected in some way by this original difference. An analysis of variance comparing the performance of 10 subjects from each of the HCE and LCE groups matched in terms of the number of nouns chosen on Trial 1 yielded a Creativity x Trials interaction term significant at the .01 level. This significant interaction suggests that the effects observed in the HCE and LCE groups cannot be accounted for in terms of the large initial difference in group means on Trial 1.

Figure 5 presents the mean number of nouns chosen per trial by the High Creative-Control (HCC) and Low Creative-Control (LCC) groups. Table 23 contains the repeated measurements analysis of variance by which the HCC and LCC groups were compared. As can be seen none of these differences is significant. The lack of significance supports the interpretation that the differences observed in the experimental conditions were due to the manipulation of the associative novelty of the stimuli.

Recall Data

Table 24 contains a comparison of the percentage of nouns recalled by the four groups after the testing session. The *t* ratio for differences in percentage of nouns recalled by the HCE and LCE groups was 3.41 (*df* = 28, *p* < .01). The *t* ratio obtained in comparing the LCC and HCC recall values was not significant (*t* = .37, *df* = 28). In view of the fact that the HCE group pronounced more nouns than the LCE group in the period of time immediately preceding the recall session this finding is not completely unexpected.

TABLE 23

REPEATED MEASUREMENTS ANALYSIS OF VARIANCE
OF HCC AND LCC GROUPS

Source	df	MS	F
Creativity	1	1.01	.02
Between subjects in same group	28	51.66	
Total between subjects	29		
Trials	3	10.64	.86
Creativity x Trials	3	11.70	.95
Interaction: Pooled subjects x Trials	84	12.36	
Total within subjects	90		

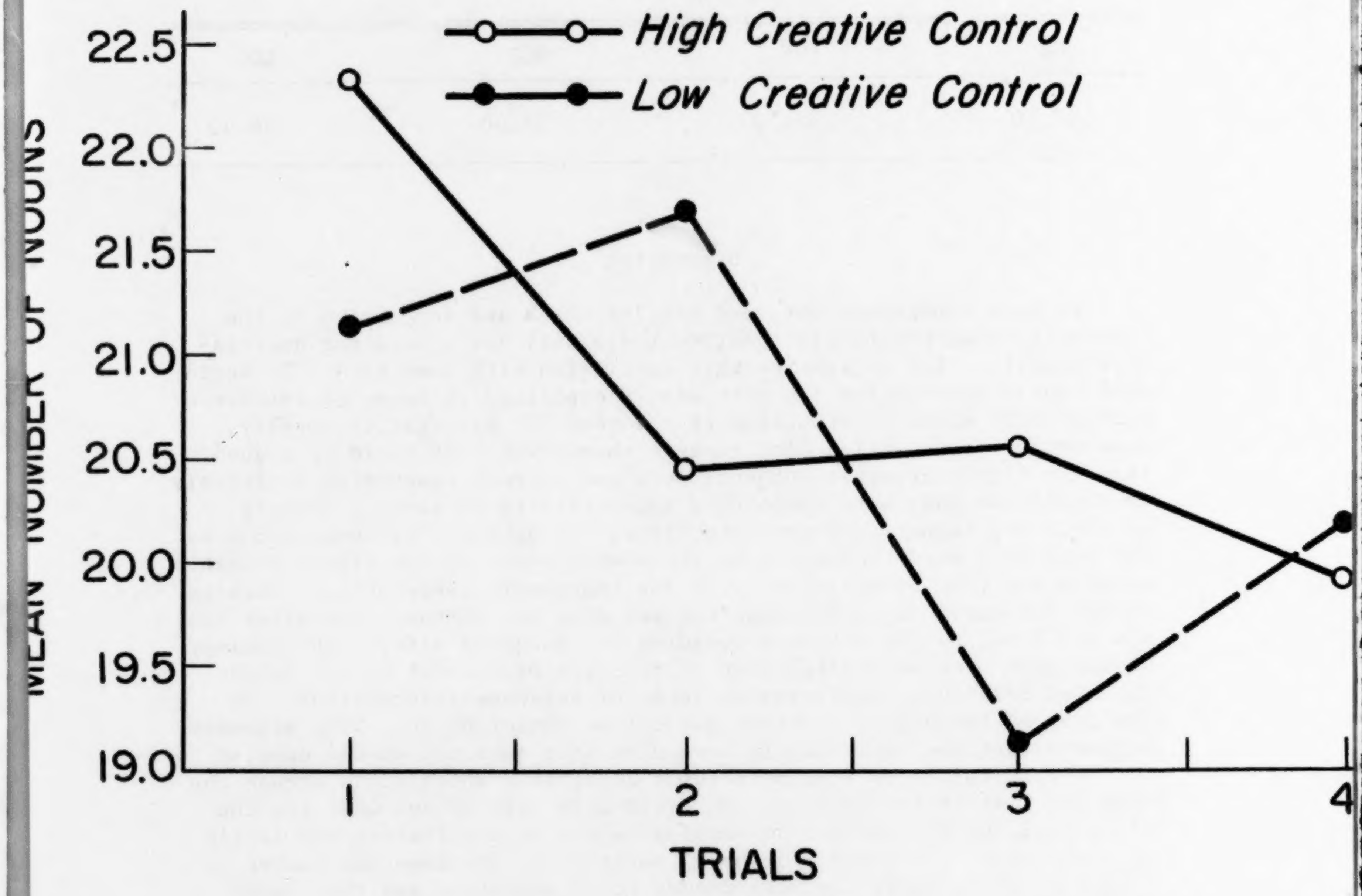

Fig. 5. Mean number of nouns chosen per trial by the HCC and LCC groups.

TABLE 24

PERCENTAGE OF NOUNS RECALLED BY THE
FOUR GROUPS

HCE	LCE	HCC	LCC
56.10	42.50	55.50	56.40

Discussion

We have apparently obtained results which are supportive to the hypothesis that the highly creative individual has a need for associative novelty. Let us examine this conclusion with some care. To begin with, while the results are most easily explained in terms of reinforcement brought about by reduction of the need for associative novelty, some other possibilities also suggest themselves. It could be argued that the highly creative subjects were not so much responding positively to novelty as they were responding negatively to banality. That is, with all due respect for our intentions, the behavior of these subjects may have been more controlled by the aversiveness of the highly probable association than by the novelty of the improbable association. This is almost analogous to saying that the rat does not approach the alley that has the food, but is actually avoiding the foodless alley. The analogy breaks down when we realize that in the case of the rat we can define the need relatively precisely in terms of antecedent conditions. In the case of the highly creative subject we cannot do so. This argument suggests that the next step in examining this question should consist of the institution of some antecedent conditions which would arouse the need for associative novelty. We could then test to see what are the effects of the interaction of varying levels of deprivation and levels of creativity. It would also be of interest to increase the number of trials so as to carry the performance to an asymptote and then note differential rates of extinction. The shortage of associational norms at the time of this study made this impossible.[2]

The noun choosing experimental subject was always presented with a novel associative stimulus. However, except for a statement of probability of S-R association we would be hard put to define precisely what we mean by novelty. Within a given level of probability the associative stimuli vary in complexity, humor, meaning, rhyme, incongruity, etc.

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[2] The norms published by Palermo and Jenkins (1964) would make possible further elaboration of this type of research.

Subsequent research might well be aimed at studying the dimension of associative novelty independently of the dimension of meaning, and vice versa.

Of considerable interest is the behavior of the low creative experimental group which shows a marked and significant tendency to avoid the improbable associations and/or approach the highly probable associations. Here again some further analytical research is needed to separate out the effect of these two variables. However, if we can for the moment argue in a mildly tautological fashion it is clear why low creative individuals become that way. The individual who eschews unusual ideas and/or prefers the highly probable is not likely to develop highly creative solutions to problems.

CHAPTER 5

SOME EFFECTS OF CONFLICT ON CREATIVE THINKING[1]

Another approach to the study of motivational factors in creativity was an exploration of the effect of conflict upon creative thinking. The study was based on an earlier one by Blake (1960) which indicated that subjects who showed pre-solution conflict about specific words were less likely to answer correctly RAT items containing those words, than subjects having no associative disturbance to the same words in the same items. According to this approach, the elements of any given problem must be free of conflictual meaning for an individual in order for him to achieve a creative solution. It is thus suggested that a person's work will be most productive when it deals with conflict-free material, and least effective when potentially conflictual elements are involved.

The RAT item paradigm was once again used as a creative problem solving task in this experiment. We tested the hypothesis that when a person showed conflicted reactions (in a pre-test) to two or more of the words of a RAT item, ~~he~~ would be unable to achieve the correct solution for that item.

Method

Subjects. The subjects for the study were 44 male undergraduates enrolled in an introductory psychology course at the University of Michigan.

Materials. The following materials were used.

RAT items. Fifty-five items were chosen from our pool of items and arranged according to ascending level of difficulty. The first five were very easy and were included only to familiarize the subjects with the task. The remaining 50 were the items to be analyzed and were divided into two groups. Thirty were at the medium difficulty level; these items had been passed by a range of 42-63 per cent (mean = 50%) of the original item analysis sample (see Part II, Chapter 2). The last twenty were difficult items (range of 17-35 per cent passing; mean = 25%).

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[1] Dr. Marion Lahn conducted this study as a dissertation under the direction of S. Mednick.

Word association task (WAT). The WAT consisted of the 195 stimulus and answer words contained in the 55 items excluding duplications.

Equipment. A standard Electric Timer, with a switch to start timing, and a voice key to stop timing were used in the word association portion of the study. A stop watch was used to record solution time for the RAT items.

Procedure. Each subject was tested individually and went through the following procedure.

WAT. The WAT was administered with the Experimenter reading the following instructions:

> I will read words to you, one by one. After each word you are to answer with the first word which occurs to you. When I give a word I will start a clock going, and your response into the mike will stop it. Therefore, it is important that you not make any extraneous noises or movements which might stop the clock before you had actually answered. Also, make sure you give your answers directly into the mike.

Four practice words were used in order to give the subject practice and to adjust the voice key if necessary. The entire list was then administered twice. Prior to the second presentation the Experimenter read these instructions.

> Now I'm going to read the same list of words to you again, and for each word, try to give the response you gave the last time. Is that clear?

During both administrations the reaction time to each word was recorded. Each response word was recorded during the first administration but only changed responses were recorded during the second round.

Remote Associate Task. Each item, typed on a 3x5 index card was individually administered and timed. A maximum time of 1.5 minutes for each item was set. The following instructions were read:

> In the last part of this experiment, you will be presented with three words and asked to find a fourth word which is related to all three. For example, what word do you think is related to these three? (Subject is presented a card with the words cookies, sixteen, heart, and given a few moments to think of an answer.) The answer in this case is sweet. Cookies are sweet, sweet is part of the phrase "sweet sixteen" and part of the word "sweetheart." Here is another example. (Subject is presented with a card with the words poke, go, molasses.) Give me your answer when you get it. (Subject is given a few moments to deliberate.) The

correct answer in this case is slow. Slow-poke, go slow, slow as molasses. As you can see, the fourth word may be related to the other three for various reasons. Try these next two. (Subject is presented with two cards in sequence: surprise, line, birthday--and base, snow, dance. He is told when his answers are correct and helped when he cannot get the sample items.)

Now we're ready to start. I will hand you each a card with the three words on it and you are to tell me your answer as soon as you get it. Many of the items are not easy and you will not be able to solve all of them. After a period of time we'll go on to the next item even if you haven't been able to give an answer to the one you were working on. This is to make sure we don't spend the whole (morning, afternoon, evening) on one item. Any questions?

Pilot testing on a comparable group of subjects had indicated that administration of the word association test immediately prior to performing the remote associate task does not have a significant effect upon performance. A t test comparing the significance of the difference between the mean scores of items for which the association task was given, with the mean score of items taken without a previous WAT, yielded a nonsignificant t value of .29.

Method of Scoring and Analysis

WAT. A stimulus word was judged to be conflicted if it showed one or more of the following complex indicators. These were based on the work of Hull and Lugoff (1921) and Rapaport (1946).

a. Repetition of the stimulus word. This appeared either as an actual repetition or as a question about what the word was. Included was nonspecific questioning of the word--e.g., implicitly questioning or seeking a repetition by the experimenter, "didn't hear," etc.

b. Long reaction time in giving a response. For each subject, reaction times on the first administration were ranked, and those above the top quartile were considered "long."

c. Assimilation of the stimulus word. This refers to incorporation of part or all of the stimulus word in the response--e.g., "shoe"--"shoe-lace" (but not "shoe"--"lace").

d. Defective reproduction of the response word. This refers to behavior during the second administration of the word association test. It is characterized by failure to remember the response word, modification of the original response word, e.g., "shoe" to "shoes" or "boot." In other words, any variation between the way the response was produced in the first administration as compared with the second administration was considered a complex indicator.

The complex indicators were not used in additive fashion. If more than one was present for a word, no assumption about greater degree of conflict was made.

Remote Associate Task. The number of items passed and solution time were the two basic scores used in the analysis of the data from this task. The subjects were divided into high and low RAT groups on the basis of their total scores on the remote associate task. A median split was the criterion for this division.

Results

The results were organized and analyzed as follows:

1. Descriptive data are presented including (a) mean of total remote associate task scores for high and low subjects and for the total group; (b) mean number of items passed for easy and hard times; (c) mean solution time for passed items; (d) mean number of conflict words for high and lows.

2. The per cent of passed items with two or more conflicted words of the total number of items with conflicted words was computed. This was compared with the per cent of passed items with no conflicted words of the total number of items with no conflicted words. Such a comparison was also made for items having one, two, three or four conflicted words.

3. Comparison of the mean solution time for passed items containing no conflicted words vs. mean solution time for passed items containing one or more conflicted words.

4. Comparison of the mean percentage of passed items in which the answer word was conflicted vs. mean percentage of passed items in which the answer word was not conflicted.

Significance of the difference between means was evaluated throughout by Student's t for correlated data.

Table 25 summarizes the data on the remote associate task for easy and hard items, high and low scoring subjects, as well as the totals in both categories. High scoring subjects had a higher percentage of correct items in both categories than did the lows. High subjects took longer to arrive at correct solutions than did the lows.

Table 26 compares per cent items passed among those items having conflicted words with those not having conflicted words in each of the item and subject categories. Looking at the hard items alone, the prediction is supported, particularly strongly for the low subjects. Both groups showed the expected direction of difference. However, for the easy items the reverse of the prediction is the case, the differences being highly significant.

TABLE 25

MEAN REMOTE ASSOCIATE TASK SCORES, MEAN PER CENT CORRECT ITEMS, MEAN SOLUTION TIMES, MEAN NUMBER OF CONFLICTED WORDS PER ITEM FOR HIGH AND LOW SCORING SUBJECTS

	High Ss	Low Ss	Total Ss
Mean total remote associate task scores	23.90	13.90	18.90
Mean total per cent correct items			
Easy	56	33	44
Hard	35	20	28
Mean solution time (correct items)			
Easy	17.08	13.49	15.28
Hard	24.89	22.28	23.58
Mean number of conflicted words per item			
Easy[a]	.82	.87	.85
Hard[b]	.82	.84	.83
Total[c]	.82	.86	.84

[a] 30 items.

[b] 20 items.

[c] 50 items.

TABLE 26

COMPARISON OF PER CENT PASSED ITEMS WITH TWO OR MORE CONFLICTED WORDS AND PER CENT PASSED ITEMS WITH NO CONFLICTED WORDS FOR EACH CATEGORY

	Easy Items				Hard Items			
	Mean % confl.	Mean % unconfl.	t	p	Mean % confl.	Mean % unconfl.	t	p
Highs	60	45	3.33	<.01	34	38	.52	NS
Lows	35	19	4.44	<.001	18	33	2.78	<.05
Total	48	32	5.00	<.001	26	35	2.04	<.05

Note: There were 21 df for the high and low Ss and 43 for the total group.

Tables 27a and b are a breakdown of the conflict-nonconflict data analysis in terms of the average number of words conflicted in an item. The results of the previous analysis are essentially repeated. It should be noted that there is a lack of independence between the t-tests for one, two, three, and four word items since the percentages for passed items with nonconflicted words remain the same throughout. The differences are therefore inflated. The results reported in both tables nevertheless support the conclusion that the presence of conflict enhances performance on easy items (50% average level of difficulty), but interferes on hard items (25% average level of difficulty).

Table 28 presents an analysis of the time differences with respect to predicted presence of conflict. In this case the length of solution time was in the predicted direction for both easy and difficult items. The low scorers appear to work faster than the high scorers.

One further analysis was performed evaluating the effect of conflict in the answer word alone. Matched pairs of items were chosen, differing only in whether or not the answer word was conflicted. The number of matched pairs available ranged from a minimum of seven pairs for one subject, to a maximum of 18 pairs for another. The analysis compared the items which had conflicted answer words with those which did not. Table 29 shows the effects of conflicted answer words on the passing of items. All comparisons tend toward decreased likelihood that items will be passed if their answers evoke conflict reactions, but all fall far short of significance. Additional comparisons, based on the combination of easy and hard items into one group were also nonsignificant. It is possible that the significance levels were reduced by the limitation of the number of items available. In order for an item to have been included in this analysis, it had to be paired with one which was like it in all respects but the answer word itself. Therefore, for some Ss, many items were excluded from the comparison because they could not be matched with any other.

TABLE 27a

COMPARISON OF PER CENT ITEMS PASSED WITH CONFLICTED WORDS WITH PER CENT ITEMS PASSED WITH NO CONFLICTED WORDS

	Easy Items		Hard Items	
	Mean % conflicted	Mean % unconflicted	Mean % conflicted	Mean % unconflicted
1 word conflicted				
Highs	56	45	34	38
Lows	32	19	18	33
Total	44	32	26	35
2 words conflicted				
Highs	59	45	32	38
Lows	32	19	16	33
Total	46	32	24	35
3 words conflicted				
Highs	65	45	35	38
Lows	39	19	23	33
Total	52	32	29	35
4 words conflicted				
Highs	14	45	14	38
Lows	33	19	7	33
Total	23	32	11	35

TABLE 27b

VALUES OF t FOR COMPARISON OF PER CENT ITEMS PASSED WITH CONFLICTED WORDS VS. PER CENT ITEMS PASSED WITH NO CONFLICTED WORDS

	t	p	t	p
1 word conflicted				
Highs	1.55	NS	.48	NS
Lows	2.36	<.05	1.95	NS
Total	2.67	<.05	1.48	NS
2 words conflicted				
Highs	3.11	<.01	.78	NS
Lows	2.36	<.05	2.70	<.05
Total	4.38	<.001	2.50	<.05
3 words conflicted				
Highs	2.38	<.05	.30	NS
Lows	3.17	<.01	1.12	NS
Total	3.64	<.01	.94	NS
4 words conflicted				
Highs	3.10	<.01	2.40	<.05
Lows	1.40	NS	3.38	<.01
Total	1.17	NS	3.75	<.001

TABLE 28

COMPARISON OF SOLUTION TIME FOR PASSED ITEMS CONTAINING NO CONFLICTED WORDS VS. SOLUTION TIME FOR PASSED ITEMS CONTAINING ONE OR MORE CONFLICTED WORDS

	Easy Items				Hard Items			
	Mean sec. unconfl.	Mean sec. confl.	t	p	Mean sec. unconfl.	Mean sec. confl.	t	p
Highs	15.42	18.74	1.14	NS	20.34	29.44	1.94	NS
Lows	9.84	17.14	1.86	NS	16.75	27.80	1.78	NS
Total	12.63	17.94	2.18	<.05	18.55	28.62	2.73	<.01

Note: There were 21 df for high and low subjects and 43 df for the total group.

TABLE 29

COMPARISON OF PER CENT PASSED ITEMS IN WHICH THE ANSWER WORD WAS CONFLICTED VS. PER CENT PASSED ITEMS IN WHICH THE ANSWER WORD WAS NOT CONFLICTED

	Easy Items				Hard Items			
	Mean % confl.	Mean % unconfl.	t	p	Mean % confl.	Mean % unconfl.	t	p
Highs	58	53	1.00	NS	37	35	.28	NS
Lows	38	33	1.00	NS	22	15	1.17	NS
Total	48	43	1.67	NS	29	25	1.00	NS

Discussion

The major finding of this study was that the presence of conflict may retard or improve creative performance depending on the difficulty level of the task. The effects of conflict were as predicted, but only for the difficult items. For the easy (actually average) items the presence of conflict had a facilitative effect. The same effect held for both high and low scorers on the task. One possible explanatory approach to this interaction may be drawn from Hullian drive theory[2] (Spence, 1956; 1958; Taylor, 1956). This theory would predict that the anxiety generated by the conflict in the situation has motivational properties which enhances performance. The prediction is rather straightforward for simple tasks in which the dominant response (association) is the correct one. The motivation (anxiety or drive) interacts with the associative strength of the answer to the stimuli and therefore makes the achievement of a correct solution more likely than in the absence of motivation (conflict). However, in the case of a complex task, the dominant association is not the correct answer, and the increased motivation therefore leads to an incorrect answer. Two bits of data support this interpretation. Garskoff (1962) found (using a standard WAT) that an increase in arousal increases the likelihood that the most probable associate will be given. In an unpublished study (M. Mednick) subjects were asked to give colloquial associations (e.g., for the stimulus paper, the type of responses required would be, news, white, boy, wall, etc.) It was found that the correct answer for easy RAT items is the most probable colloquial association to the elements of the item. The drive explanation seems a tenable one, but requires further testing.

Results of the analyses of solution time data indicate that more time was needed to solve conflict-laden than nonconflicted items. This was as predicted. Group differences show that low RAT subjects correctly answer nonconflicted items faster than the highs. It will be recalled that associative theory predicts low RAT scorers to have a steeper associative hierarchy than high scorers. Although it is hard for low subjects to get beyond their most probable associations, they can produce these few rapidly and readily. This could account for their greater speed on the easy items. Schlosberg and Heineman (1950) also offer evidence for this. They find that responses are given more quickly when a subject has a limited number of associations. With conflicted items, the differences in speed between highs and lows are much smaller.

With regard to comparisons of number of conflicted words in an item, two or more conflicted words appear to be the most reliable measure of item performance of those investigated. For the hard items, the data confirm the results of the Blake study (1960) and support the prediction of the present work. As pointed out above, with the easy items this criterion discriminates equally well, but in the reverse direction. Item difficulty levels from the Blake study were not available for comparison, but it seems likely that her results were based on more difficult items. The conflicted vs. nonconflicted answer word did not have any additional effect on performance.

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[2] The reader is strongly encouraged to refer to one of the cited references for detailed presentation of drive theory. The above explanation is severely curtailed.

Although the concern of this study was to investigate the effects of conflict on creative thinking, it is obvious that factors other than anxiety-related conflicts influence item performance. One such factor is fluency of association. Other work (Part III, Chapter 2) has found high and low RAT scorers to be differentiated on this dimension. Highs are able to produce considerably more associations to words than lows. Though conflict facilitated performance on easy items for both groups, the highs still had a higher percentage correct, and this held for their performance on hard items where conflict was inhibiting. Thus their success is also of course related to the greater availability of associations to be tried as potential answers. This is further supported by the fact that conflict does not differentiate high from lows--there were no major differences between them in actual number of conflicted words. Therefore, it appears that specific effects of conflict on performance--facilitation for easy items, inhibition for hard ones--have been found, but that the performance itself is a function of at least one additional variable--availability of potential answers.

CHAPTER 6

CREATIVE POTENTIAL AND CHILDHOOD ANTECEDENTS[1]

This study was concerned with childhood antecedents of creativity as measured by the RAT. The design of the study contains two distinct parts. In view of the dearth of published material linking creative potential and antecedent childrearing conditions, an exploratory investigation was necessary. However, to the extent that any exploratory findings could be depended upon, they must be shown to be replicable. Thus, Phase I of the study was exploratory in nature, while Phase II involved the testing of predictions generated from the results of Phase I.

Phase I

Method

Subjects

One hundred forty-eight children, aged thirteen to fifteen, served as subjects. These children were members of two East Coast school districts, and they were part of a larger group which had participated in a childrearing study while in third grade.[2] The Ss from each of the two school districts differed in education level of parents and in family income; but they did not differ in parent occupational status nor--most importantly--in either means or variances on the dependent variable (RAT). Therefore, Ss from the two school districts were combined for the present analysis. Furthermore, males and females were not separated because they did not differ on either the dependent variable or relevant demographic variables.

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[1] The author of this chapter is Dr. Gerald P. Ginsburg, Department of Psychology, University of Nevada. It is based on his dissertation which was co-directed by S. Mednick. The reader is urged to refer to the original thesis (Ginsburg, 1964) for an extensive review of published investigations of creativity.

[2] In 1956, 224 third graders had participated in a study in which Mednick had been involved. The childrearing data used in Phase I of the present study, as well as the list of Ss, were made available to the author by Dr. Mednick.

Instruments

In 1956, while the Ss were in third grade, their parents gave detailed retrospective reports of their childrearing practices and the background conditions of the children by means of both a check-list questionnaire and a two-hour interview. Six months later, the children were subjected to a battery of intellectual aptitude and performance tests. Third grade teachers' ratings also were gathered for a wide variety of classroom behaviors of the children. Forty-one variables from these data sources were selected for the basic analysis. The RAT was administered to the Ss while they were in ninth grade, six years after the childrearing data had been gathered.

Design

The forty-one childhood variables whose relations to RAT performance were to be examined were selected on two criteria: (1) they had to be at least ordinally scaled and roughly approximate interval scaling, and (2) their distributions could not be drastically skewed. The one exception to these rules was sex, which was selected as a control variable. Preliminary analyses has shown that the relations between childhood conditions and later RAT performance could change drastically as a function of sex and IQ score. The analysis design was heavily determined by these preliminary findings.

The general objective of the study implied testing for differences between the means of high RAT scorers and low RAT scorers on each of the antecedent childhood variables. To implement this objective a one-way analysis of variance design was used, with controls on sex and verbal intelligence (WISC Verbal subscores). Eight subgroups were formed, based on median splits on RAT (median score = 10.5) and WISC Verbal (median score = 110.5), as well as a sex split: Male, High IQ, High RAT; Male, High IQ, Low RAT; Male, Low IQ, High RAT; Male, Low IQ, Low RAT; and four equivalent groups for Females. Mean RAT scores among the four High RAT groups did not differ significantly, nor did the RAT means differ among the four Low RAT groups. Similarly, mean Verbal IQ scores among the four Low IQ groups did not differ significantly, and the mean IQ scores among the four High IQ groups were roughly the same.[3]

The design required for a comparison of the antecedent variable means within four pairs of the subgroups. For each antecedent variable, for example, the mean of the Male, High IQ, High RAT subgroup was compared with that of the Male, High IQ, Low RAT subgroup. Shown below is a schematic representation of the comparisons which were planned (the means of cells containing the same letter were compared). The parenthesized numbers show the n in each cell.

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[3] High IQ Males (combined High and Low RATs) differed at the .25 level from High IQ Females, but the magnitude of the difference between the means was only 3.52. It was felt that such a small difference could be disregarded safely.

Male				Female			
Hi IQ		Lo IQ		Hi IQ		Lo IQ	
Hi RAT	Lo RAT	Hi RAT	Lo RAT	Hi RAT	Lo RAT	Hi RAT	Lo RAT
A	A	B	B	C	C	D	D
(29)	(13)	(8)	(29)	(17)	(8)	(14)	(30)

These were *a priori* comparisons, since they were specified before the analysis. The difference between means within each *a priori* comparison was tested by F ratios (Winer, 1962, pp. 65-70).[4] In the cases of antecedent variables which had significant overall F ratios, *a posteriori* comparison were made between Males and Females and between High IQs and low IQs. The conservative Scheffe method (Winer, 1962, pp. 85-89) was used to estimate the significance of the differences between means in the *a posteriori* comparisons;[5] however, the results of *a posteriori* tests will be omitted from the Phase I report since they generally were of only peripheral interest.

A limited number of hypotheses were extracted from the results of the exploratory analyses. A wide range of published studies of creativity and of childrearing practices was used as a framework for interpreting the exploratory data and generating the hypotheses. The resulting hypotheses then were tested on an independent sample, and this comprised Phase II of the research.

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[4] *A priori* testing involved the following steps:

$$\hat{\psi} = \bar{X}_1 - \bar{X}_2$$

$$SS_{\hat{\psi}} = \frac{(\hat{\psi})^2}{1/n_1 + 1/n_2}$$

$$F = \frac{SS_{\hat{\psi}}}{MS_E}$$

Where $SS_{\hat{\psi}}$ is the sum of squares of the comparison and MS_E is the mean square error of the overall analysis of variance of the antecedent variable (i.e., of the single-factor, 8-group analysis of variance).

[5] The Scheffe method is the only test which both ensures that the probability of a Type I error (erroneously rejecting the null hypotheses) is at most α for any comparisons, *and* can be used with unequal cell sizes. Other less conservative tests exist which meet the former requirement, but they require cells of equal sizes.

TABLE 30

SUMMARY OF ANALYSES OF VARIANCE AND DIFFERENCES BETWEEN SUBGROUP MEANS[a]

(Parent interview and questionnaire)

Var. No.	Raw r with RAT	Independent Variable (I.V.)	Meaning of I.V. high score	Total group	Control Groups			
					Male		Female	
					Hi IQ	Lo IQ	Hi IQ	Lo IQ
2	-21	Embedded Figures Test	Lo Field Indep	L > H.05			L < H.25	
3	-15	Manifest Anxiety Scale (children)	Hi	L > H.01		L > H.10	L < H.25	
4	06	Toilet Tng. Stress	Hi	L > H.01	H > L.25	H > L.25	H < L.25	
6	-10	Age Talked	Late				H < L.25	
7	-10	Tidiness of Child	Untidy	L > H.05			L < H.25	L < H.05
8	08	Tidiness of Father	Untidy			H > L.25	H < L.25	L < H.25
9	-03	Obedience Training by Mother	Lax	L > H.25	L > H.05			
10	-05	Obedience Training by Father	Lax		L > H.25			
11	-05	Obedience to Mother	Talks back	L > H.10				L < H.25
12	-23	Obedience to Father	Talks back	L > H.10				

TABLE 30--(CONTINUED)

Var. No.	Raw r with RAT	Independent Variable (I.V.)	Meaning of I.V. high score	Total group	Control Groups			
					Male		Female	
					Hi IQ	Lo IQ	Hi IQ	Lo IQ
13	04	Frequency of reading to child now	Seldom			H > L.25		
14	-11	Parent perception: child's guilt reaction	Seldom	L > H.05	L > H.25	L > H.25		L > H.25
15	26	Books owned by child	Number	L > H.01				L > L.10
16	-19	Frequency child checks books out	Seldom		H > L.10			
17	25	Hours/week lessons, etc.	# Hours	H > L.05		H > L.10		H > L.25
18	-22	Hours/week pleasure riding, etc. with family	# Hours	L > H.05	L > H.25	H > L.25		
19		Age bed-wetting control	Late					L > H.25
20	-11	Threats, not followed through	Often	L > H.01				L > H.05
21	-03	Time father spends with child	Little	L > H.25			L > H.25	L > H.10
22	-22	How child gets along with siblings	Poorly	L > H.25	L > H.25			

TABLE 30--(CONTINUED)

Var. No.	Raw r with RAT	Independent Variable (I.V.)	Meaning of I.V. high score	Total group	Control Groups			
					Male		Female	
					Hi IQ	Lo IQ	Hi IQ	Lo IQ
23	-06	Child's worry re school	Hi			L > H.25		
24	-19	Often remind him to do better	Often	L > H.01		L > H.05		
25	17	Mother's education	Some grad	H > L.10			H > L.25	

[a] The first column on the left (Variable Number) contains the identification number of each antecedent variable. The second column contains the product-moment correlation between RAT and each antecedent variable. The third and fourth columns give the title of the antecedent variable and the meaning of a high score on that variable. The fifth column (Total Group) is based on the comparison of all High RATs with all Low RATs for each antecedent variable. An entry in this column conveys the following information: the mean of one group (High RAT or Low RAT) was greater than (>) that of the other group (Low RAT or High RAT), and the difference was significant beyond the level of probability shown in the entry. For example, the Low RAT group obtained a higher mean score than the High RAT group on the Taylor Manifest Anxiety Scale for Children (Var. No. 2) and that the difference was significant at the .01 level. The entries in this column are not corrected for IQ, however, and the differences very likely are due as much to IQ as to RAT.

The sixth through ninth columns (Control Groups) are corrected for IQ and are separated by sex. These columns represent the basic design of analysis presented earlier. The method of presentation is identical to that described for the fifth column, with *a priori* tests being used to estimate the significance of differences between High and Low RATs within each control group.

TABLE 31

SUMMARY OF ANALYSES OF VARIANCE AND DIFFERENCES BETWEEN SUBGROUP MEANS[a]

(Third grade teacher ratings and age)

Variable Number	Independent Variable (I.V.)	Meaning of I.V. high score	Control Groups			
			Male		Female	
			Hi IQ	Lo IQ	Hi IQ	Lo IQ
1	Happy vs. Depressed, irritable	Depressed		L > H.10		
2	Aggression w/ children	Very aggressive			H > L.25	
3	Submission vs. aggression, w/adults	Outwardly aggressive				
4	Self control	Impulsive, hyperactive			H > L.25	
5	Obedience and conduct	Troublesome			H > L.25	L > H.25
6	Social acceptability	Disliked, ignored	L > H.05	L > H.10		L > H.25
7	Leadership	Can't be a leader		L > H.01		
8	Risk-taking	Flippantly guesses				

TABLE 31--(CONTINUED)

Variable Number	Independent Variable (I.V.)	Meaning of I.V. high score	Control Groups: Male Hi IQ	Control Groups: Male Lo IQ	Control Groups: Female Hi IQ	Control Groups: Female Lo IQ
9	Self-confidence in problem solving	Self derogatory and insecure		L > H.25		L > H.05
10	Nonreading intelligence (teacher eval.)	Slow, act unwisely		L > H.05		L > H.05
11	Classroom achievement	Always fails	L > H.05	L > H.01		L > H.10
12	Classroom reading performance	Very slow	L > H.05	L > H.05		
13	Teacher's personal reaction to child	Better cooperation without him	L > H.25			L > H.05
14	Parent cooperation	Little or no interest				
15	Teacher eval: Parent achievement pressure on child	Little or no interest				
16	Child's demands vs. quality of own performance	Unmotivated and careless				

TABLE 31--(CONTINUED)

Variable Number	Independent Variable (I.V.)	Meaning of I.V. high score	Control Groups			
			Male		Female	
			Hi IQ	Lo IQ	Hi IQ	Lo IQ
17	Home situation as promoting learning experiences	Home detrimental		L > H.10		L > H.05
18	Age	(Months)		L > H.05	H > L.10	

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[a] The format for this table is the same as that of Table 30, except that the second and fifth columns of Table 30 are not present in Table 31.

Results

A summary of the results of the exploratory analyses is shown in Tables 30 and 31. Table 30 summarizes the parent interview and questionnaire data, as well as two of the performances measures (Variables 1 and 2). Table 31 summarizes the Teachers' Ratings data. Explanatory notes for interpreting the tables can be found at the end of each table.

General pictures implied by the comparisons can be presented for each of the four control groups. The High IQ Males with high creative potential appear to be nice, bright, pleasant, conforming youngsters who have a control mechanism of guilt and a sense of responsibility and who experienced higher demands by the family for adequate performance of socially expected behaviors. Yet, these same boys later proved to have higher creative potential, as measured by the RAT, which means that they have the capacity to produce unusual, nonconforming (but meaningful) responses.

The Hi RATs in the Low IQ Male control group, relative to the Low RATs in that group, also appear to be brighter, more cheerful, more responsible and more internally controlled children, and they tend to be a few months older. High RAT boys in both control groups do less "socializing" with their families than the Low RATs, and they tend to be better readers in class.

The impressions gleaned from the Low IQ Females are consistent with the picture presented by the two male groups. The High RAT Low IQ girls, relative to comparable Low RATs, seem to have received greater consistency in discipline and to be more obedient and less prone to talk back. They seem to have a higher degree of internal control, to be more responsible about schoolwork, and to be brighter. A factor which sets them off from the males, though, is that the High RAT girls in the Low IQ group spend more time with their fathers than do the Low RAT girls.

The High RAT girls in the High IQ Female group also spend more time with their fathers than do the Low RAT, High IQ girls; but the High RAT girls in the High IQ group are less anxious, more independent children who conform less to stereotypic little-girl behavior norms, although they are tidier than their Low RAT compatriots.

The general implications of these findings are that the children with high creative potential appear to have experienced greater demands for self control of their impulses and to have attained a higher degree of self control. They also appear to be more likeable children and to be more responsible in terms of schoolwork. This pattern, as it stands, is inconsistent with the impressions of other writers (Barron, 1963; Getzels and Jackson, 1962), epitomized by Torrance when he described his second grade high creatives as "little brats" (1959, p. 65). In fact, only among the High IQ Females do the High RATs conform to the impulsive, independent picture described by other writers.

The lack of articulation between the present data and those of other writers may be due in part to differences in criterion measures. In studies where creativity was measured by performance on various instruments designed specifically for that purpose (e.g., Getzels and Jackson, 1962; Torrance, 1959), high scores were earned for original (i.e., unusual) behaviors, but there were no specific requirements or performance criteria which the Ss had to meet. The necessity of including a quality or usefulness criterion in any measure of creativity, in order to differentiate creative behavior from original behavior has been continually stressed in the present approach. The RAT has such a built-in criterion, but the measures used elsewhere do not. Thus, Ss selected as highly creative by other researchers may well have included a large number of impulsive, original children who do not evaluate the quality of their original ideas in terms of the requirements of the situation. With this consideration in mind, certain inferences about the influence of early childhood experiences upon the development of creative potential were drawn from the exploratory data. The inferences, presented below, were guided by Mednick"s (1962) theory of the creative process as well as by other empirical reports of creativity (cf. Ginsburg, 1964, for details).

It was inferred that Ss with high creative potential underwent a very early and nonrejectant fostering of responsible autonomy. That is, the child was trained not only to be relatively autonomous; he also was trained to control the expression of impulses which would be unacceptable to his mother and to adequately meet the demands of typical home situations. Thus, the mother did not have to watch him closely and constantly, and he had the freedom to encounter a wider variety of stimuli and to perform a wider variety of responses.

It was further inferred that High RATs displayed, as youngsters, a greater tendency to immediately reveal their misbehaviors and to "make it right"--i.e., they maintained a pattern of openness which in turn served to facilitate the maintenance of their autonomy. Once again, the parent was free of having to watch the child constantly, and the child thereby could act and think with greater autonomy.

It was felt that the pattern of openness about misdemeanors served to reduce the contingency of the child's behaviors upon the expectations and reactions of others. This in turn should lead to less conflict within the person with high creative potential. Finally, it was felt that there was less stereotypic sex role identification among the High RAT children.

The above inferences were translated into hypotheses which served as code categories in Phase II. As will be seen below, the available information in the Phase II study was coded, prior to analysis, into one or another of the inferential categories, and predictions then were made regarding a large number of the Phase II antecedent variables.

Phase II

Method[6]

The Ss in Phase II were similar in age and school grade (ninth grade) to the Phase I Ss. Childrearing and performance data had been gathered over a period of years preceding the administration of the RAT. Phase II Ss were from a different East Coast state, were members of a public school, and did not differ from Phase I Ss on demographic background variables. However, all Phase II Ss were males, and Phase II Ss were thirteen years old when their mothers were given the childrearing interviews (compared with age eight for Phase I Ss). Furthermore, the Phase II Ss were significantly higher on WISC Verbal IQ than were Phase I Ss (means of 118.61 and 112.81, respectively; $p < .01$). The ramifications of the latter differences will be discussed later. Fifty Ss comprised the Phase II sample.

Instruments

Phase II data included interviews with mothers regarding their childrearing practices of the past and of the present and observations of contemporary performances of the children on a wide range of measures (n Achievement, self esteem, manifest anxiety, intelligence, originality, and conformity). In addition, the RAT was administered while Ss were in the ninth grade.

Ninety-nine variables were used in the Phase II analysis. Predictions were made for fifty-four of these on the basis of coding them into the inferential categories generated by the Phase I data.

Design

An analysis of variance design, similar to that of Phase I, was used. The sample was broken into High and Low RAT groups and into High and Low IQ groups (based on WISC Verbal scores). The mean IQ scores of the High IQ, Low RAT group and High IQ, High RAT group did not differ significantly, nor did the mean IQ scores of the High and Low RAT subgroups of the Low IQ group. Furthermore, the mean RAT scores of the High and Low IQ subgroups within the High RAT group were equated, as were the mean RAT scores of the two Low RAT subgroups. The equating process reduced the original N somewhat, and it was reduced further by equating the cell frequencies. The final N in each of the four cells was 11, yielding a total N of 44.

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[6] The data in Phase II graciously were given to the author by Dr. Stanley Coopersmith, Chairman, Department of Psychology, University of California at Davis. The author is grateful to Dr. Coopersmith not only for the childrearing data but also for administering the RAT to the Phase II Ss.

The analysis of variance design was as follows: A four-group, one-way analysis was done on each of the ninety-nine antecedent variables. For each variable, comparisons are made between the High IQ, High RAT and High IQ, Low RAT groups, and between the Low IQ, High RAT and Low IQ, Low RAT groups. Specific directional predictions were made for fifty-four of the antecedent variables. _A priori_ comparisons between the High and Low RAT subgroups within each of the two IQ control groups were performed in the cases of both the fifty-four predicted variables and the remaining nonpredicted variables. In addition, _a posteriori_ comparisons (Scheffé method) were performed, when appropriate, on several interesting relationships.

Results

The major results of the predictive study (Phase II) are shown in Tables 32, 33, and 34. Interpretation of the tables may be guided by the Explanatory Note provided at the end of each table.

High IQ Group. Broader background experience (more urban background, higher education) of the mother, but not of the father, differentiated the High RATs from the Low RATs. The groups did not differ in toilet training procedures or in other forms of early autonomy training. Neither did they differ in attempts at early intrusion and control, except that the High RATs' mothers reported less respect for the boys' privacy. Also, the mothers of High RATs were less concerned about their sons sleeping out. The High RAT boys appear closer to their mothers than do the Low RAT boys, but there are no differences between the groups in regard to father-son variables or whole-family variables. Father-mother disagreement is lower in the High RATs' families, but there are no differences in degree of observed emotional disturbances. More punishment was used in the early days in High RATs' families, and the High RATs were less affectionate than Low RATs when younger; and currently, the High RATs are better behaved. On many other early history and contemporary variables the groups showed no differences: child-centeredness of the home, closeness with father and family, mother's acceptance of her role, punitiveness, mother's love for son, and whether or not mother wanted children. High RATs' mothers tend to hold themselves in lower esteem, and their sons tend to behave in a fashion which implies lower self esteem to others (e.g., their schoolteachers). On the other hand, High RATs' mothers think highly of their sons (in terms of their sons' abilities) and rate them as comparatively superior. Despite their apparently lower self esteem, the High RATs spoke out more frequently against an erroneous majority; but they also displayed higher manifest anxiety. The groups did not differ in terms of occupational mobility or in parents' degree of religious involvement; nor did they differ in risk preferences of the boys. Finally, it should be remembered that both groups are very high in intelligence.

TABLE 32

SUMMARY OF ANALYSES OF VARIANCE (PREDICTIVE STUDY), PREDICTED VARIABLES[a]

Var. No.	Meaning of High Score	General F	Prediction	A Priori Contrasts Hi IQ	 Lo IQ	A Posteriori Contrasts Hi IQ x Lo IQ	 Other
1	Mother's family in US ≥ 3 generations	$.25>p(F)>.10$	Lo>Hi	NS	H>L.25	NS	(HH+HL+LH)-LL: NS
2	Father's family in US ≥ 3 generations	$.25>p(F)>.10$	Lo>Hi	L>H.10	NS	NS	(HL+LL)-(HH+LH): NS
3	Mother's childhood urban	$.01>p(F)$	Hi>Lo	H>L.10	L>H.01	NS	(HH+LL)-(HL+LH): p>.01
4	Father's childhood urban	NS	Hi>Lo	NS	NS		
5	Mixed marriage (religions)	NS	Hi>Lo	NS	NS		
8	Mother's schooling ≤ grade school	NS	Lo>Hi	L>H.25	NS		
9	Father's schooling ≤ grade school	NS	Lo>Hi	NS	L>H.25		
10	Father's occupation: unskilled (Warner)	NS	Lo>Hi	NS	L>H.25		
16	Very low geographical mobility of home	NS	Lo>Hi	NS	H>L.25		

TABLE 32--(CONTINUED)

Var. No.	Meaning of High Score	General F	Prediction	A Priori Contrasts		A Posteriori Contrasts	
				HI IQ	Lo IQ	Hi IQ x Lo IQ	Other
41	Begin nursery rhymes early (attitude statement)	NS	Hi>Lo	NS	NS		
14	Mother: Doesn't plan to continue a career	NS	Lo>Hi	NS	NS		
23	Started toilet training later than 24 months	$.25>p(F)>.10$	Lo>Hi	NS	H>L.10	NS	
24	Bladder trained later than 32 months	NS	Lo>Hi	NS	NS		
25	Children can be bladder trained in less than one year	NS	Hi>Lo	NS	L>H.25		
26	Children should be bladder trained in less than one year	NS	Hi>Lo	NS	NS		
27	Age independent activity: later than 7 years	NS	Lo>Hi		NS		
37	Punishment was mild, rare	NS	Hi>Lo	NS	NS		
39	Child solve own problems? Needs help	NS	Lo>Hi	NS	NS		

TABLE 32--(CONTINUED)

Var. No.	Meaning of High Score	General F	Prediction	A Priori Contrasts Hi IQ	A Priori Contrasts Lo IQ	A Posteriori Contrasts Hi IQ x Lo IQ	A Posteriori Contrasts Other
40	Preschool teaching: quite important	$.25>p(F)>.10$	Lo>Hi	NS	L>H.05	NS	(HH+HL+LH)-(LL): NS
58	Mother respects child's right to have private thoughts	$.25>p(F)>.10$	Hi>Lo	L>H.25	L>H.25	NS	
29	Little concern over child's sleeping out	NS	Hi>Lo	H>L.25	H>L.25		
32	Parents not very concerned re destructiveness of child	NS	Hi>Lo	NS	NS		
33	Parents: little concern with and rarely use discipline	NS	Hi>Lo	NS	NS		
36	Child shows high guilt, and never denies, when naughty	NS	Hi>Lo	NS	NS		
43	Rewards: not important; absence of punishment enough	NS	Lo>Hi	NS	NS		
49	Mother's attitude: child is unique and she accepts (vs. complains)	NS	Hi>Lo	NS	NS		

TABLE 32--(CONTINUED)

Var. No.	Meaning of High Score	General F	Prediction	A Priori Contrasts		A Posteriori Contrasts	
				Hi IQ	Lo IQ	Hi IQ x Lo IQ	Other
57	Mother: child always confided in me	NS	Hi>Lo	NS	NS		
64	Mother expects immediate obedience	NS	Lo>Hi	NS	NS		
67	Many restrictions on child	NS	Lo>Hi	NS	H>L.25		
70	"Superego": Child shows high guilt	NS	Hi>Lo	H>L.25	L>H.25		
71	Parent does not allow child to question authority	.25>p[F]>.10	Lo>Hi	NS	L>H.10	NS	
74	Low compliance demands by parents	NS	Hi>Lo	NS	NS		
75	Physical privacy: mother feels no one has right to full privacy	NS	Lo>Hi	H>L.10	NS		
76	Mother tries to control child's choice of playmates	NS	Lo>Hi	NS	NS		
77	Mother always wants to know son's whereabouts	.25>p[F]>.10	Lo>Hi	NS	NS	L>H.25	

TABLE 32--(CONTINUED)

Var. No.	Meaning of High Score	General F	Prediction	A Priori Contrasts		A Posteriori Contrasts	
				Hi IQ	Lo IQ	Hi IQ x Lo IQ	Other
78	Parental intrusion and control: nonintrusive	NS	Hi>Lo	NS	NS		
79	Rigidity of parental decisions: open system	NS	Hi>Lo	NS	NS		
83	Parent-child differences in aspirations: parents decide	NS	Lo>Hi	NS	NS		
84	Child extremely independent	NS	Hi>Lo	NS	NS		
86	Mother's reaction to underachievement: extreme pressure	NS	Lo>Hi	NS	NS		
87	Parents make few achievement demands	NS	Hi>Lo	NS	NS		
88	Parents show little concern *re* underachievement	NS	Hi>Lo	NS	NS		
51	Mother and son time together: great deal	NS	Hi>Lo	H>L.25	NS		
52	Father and son time together: great deal	NS	Lo>Hi	NS	NS		

TABLE 32--(CONTINUED)

Var. No.	Meaning of High Score	General F	Prediction	A Priori Contrasts		A Posteriori Contrasts	
				Hi IQ	Lo IQ	Hi IQ x Lo IQ	Other
53	Family: much time together	NS	Lo>Hi	NS	NS		
54	Quantity and quality of father-son interaction: maximal	NS	Lo>Hi	NS	NS		
59	Mother-son relationship: distant, "frictions"	NS	Lo>Hi	NS	L>H.25		
17	Evidence of serious emotional disturbance	NS	Lo>Hi	NS	NS		
18	Serious or frequent delinquency	NS	Lo>Hi	NS	NS		
21	Complete, constant mother-father disagreement	NS	Lo>Hi	L>H.25	NS		
46	Child came at good, convenient time	NS	Hi>Lo	NS	H>L.25		

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[a] The format of this table is identical to that of Tables 30 and 31, with the following exceptions: The third column ("General F") reports the results of the overall analysis of variance, the fourth column ("Prediction") reflects which group (High or Low RAT) was expected to have a higher mean on the antecedent variable, and the last two columns show the results of _a posteriori_ comparisons. The first _a posteriori_ column refers to High vs. Low IQ comparisons, while the last column shows miscellaneous posteriori comparisons (HH refers to High IQ, High RAT; HL refers to High IQ, Low RAT; LH refers to Low IQ, High RAT; and LL refers to Low IQ, Low RAT).

TABLE 33

SUMMARY OF ANALYSES OF VARIANCE (PREDICTIVE STUDY), NONPREDICTED VARIABLES[a]

Var. No.	Meaning of High Score	General F	A Priori Contrasts Hi IQ	A Priori Contrasts Lo IQ	A Posteriori Contrasts Hi IQ x Lo IQ	A Posteriori Contrasts Other
22	Mother reports unconditional love (vs. rejection) for son	NS	NS	H>L.10		
28	Mother rejects (or has conflict) re her role	$.05>p\{F\}< .01$	NS	L>H.01	NS	(HH+HL+LH)-(LL): $p<.10$
30	Child (in younger days) always affectionate	$.01>p\{F\}$	L>H.01	H>L.05	NS	(HL+LH)-(HH+LL): $p<.01$
31	Mother never (vs. always) enjoyed child	NS	NS	L>H.25		
34	Extensive and pervasive punishment	$.25>p\{F\}>.10$	H>L.05	NS	NS	
35	Punishment always carried out (in younger days)	NS	NS	NS		
38	Important to let child know that he did well (vs. "don't reward")	$.25>p\{F\}>.10$	NS	NS	L>H.25	
42	Child has little concern with (vs. extreme compulsion) responsibility	$.10>p\{F\}>.01$	NS	H>L.05	NS	(HH+HL+LH)-(LL): $p<.10$
47	Mother did not want children (vs. wanted self-fulfillment)	NS	NS	NS		

TABLE 33--(CONTINUED)

Var. No.	Meaning of High Score	General F	A Priori Contrasts		A Posteriori Contrasts	
			Hi IQ	Lo IQ	Hi IQ x Lo IQ	Other
48	Child always easy and good to have around	NS	NS	H>L.10		
55	Father-son rapport close, confident	NS	NS	NS		
56	Child enjoys joint activities with parents	NS	NS	NS		
60	Father-child relation distant, "frictions"	NS	NS	L>H.25		
61	Mother gives high approval for performing mother-centered acts (e.g., housework)	NS	NS	NS		
62	Approval given almost exclusively for child-centered acts	.25>p{F}>.10	NS	NS	NS	(HH+HL+LL)-(LH): NS
63	Child very well behaved	NS	H>L.25	NS		
65	Home democracy: child always consulted _re_ family decisions	.01>p{F}	NS	H>L.10	L>H.05	(LH)-(HH+HL+LL):p<.05 (LL)-(HH+HL): NS (The above two contrasts are mutually orthogonal; the following contrast is not orthogonal to the above, nor is it to the IQ contrast.) (LH)-(HH+HL): p<.01

TABLE 33--(CONTINUED)

Va. No.	Meaning of High Score	General F	A Priori Contrasts		A Posteriori Contrasts	
			Hi IQ	Lo IQ	Hi IQ x Lo IQ	Other
66	Mother believes in discussion and reward (vs. force)	NS	NS	NS		
68	Amount of punishment: extreme	NS	NS	NS		
69	Punishment always (vs. never) carried out (contemporary)	NS	NS	H>L.25		
72	(Scale) Parent- (vs. child-) centered	NS	NS	NS		
73	(Scale) Mild, nonpunitive (vs. high)	.25>p[F]>.10	NS	NS	L>H.25	
6	Mother's religious involvement: none	NS	NS	NS		
7	Father's religious involvement: none	NS	NS	NS		
11	Husband: downward occupational mobility (Warner)	NS	NS	L>H.25		
12	Wife's occupation: never worked (vs. Professional)	NS	NS	NS	-	By inspection of frequencies, no differences in "Never worked": HH 2, HL 2, LH 1, LL 0.
15	Mother: downward occupational mobility (Warner)	NS	NS	NS		

TABLE 33--(CONTINUED)

Var. No.	Meaning of High Score	General F	A Priori Contrasts		A Posteriori Contrasts	
			Hi IQ	Lo IQ	Hi IQ x Lo IQ	Other
19	Interviewer rating: mother has high subjective self-esteem	.25>p(F)>.10	L>H.25	H>L.10	NS	(HL+LH)-(HH+LL): p>.25
20	Interviewer rating: mother's behavior reflects high self-esteem	.25>p(F)>.10	NS	H>L.10	NS	(HH+HL+LH)-(LL): NS
80	Child seems content to stay where he is (vs. try new things)	NS	NS	NS		
81	Mother's aspirations for son: service (vs. professional)	NS	NS	NS		
82	Father's aspirations for son: service (vs. professional)	.05>p(F)>.01	NS	L>H.01	NS	(LL)-(HH+HL+LH): p<.05 (HH+HL)-(LH): NS
85	Mother's estimate: son now living up to full potential	NS	H>L.25	H>L.25		
89	Mother's estimate: son's intelligence much above average	.01>p(F)	H>L.10	NS	H>L.05	
90	(Scale) Mother's estimate of child: inferior (vs. exceptional)	.05>p(F)>.01	L>H.25	L>H.25	L>H.25	

TABLE 33--(CONTINUED)

Var. No.	Meaning of High Score	General F	A Priori Contrasts		A Posteriori Contrasts	
			Hi IQ	Lo IQ	Hi IQ x Lo IQ	Other
91[b]	High subjective self-esteem (child)	NS	NS	H>L.25		
92[b]	Behavior reflects high self-esteem (child)	$.10>p\{F\}>.05$	L>H.25	H>L.25	NS	
93[b]	(Behav. Self-esteem)-(Subj. Self-esteem)	NS	NS	NS		
94[b]	Age in months at time of testing	NS	NS	NS		
95[b]	n Ach (arousal condition)	$.10>p\{F\}>.05$	NS	L>H.10	NS	
96[b]	Taylor MAS-Children	NS	H>L.25	NS		
99[b]	Number of times publicly disagreed when majority was wrong	$.25>p\{F\}>.10$	H>L.25	L>H.05	NS	(HH+LL)-(LH+HL): $p<.25$ (HH)-(LL): NS (HL)-(LH): NS

[a] The format of this table is the same as that of Table 32, except that this table does not contain a Prediction column.

[b] Variables 91, 92, 93, 94, 95 and 96 are noninterview, basic identification data. Variable 99 is based on observed performance in a conformity experiment.

TABLE 34

SUMMARY OF CHI SQUARE PARTITIONINGS, PART II[a]

Var. No.	Description of Variable	Prediction[b]	Results of Partitioning[c]			"Simple Effects" [if $p(IQ \times RAT \times C) < .20$][d]			
			IQxC	RATxC	IQxRATxC	Hi IQ	Lo IQ	Hi RAT	Lo RAT
13	Did you (mother) ever plan to have a career?	"Yes": Hi>Lo	NS	H>L.20	NS				
44	Did mother work before birth of child?	"Regularly": Hi>Lo	L>H.20	NS	$p<.20$	NS	H>L.05	L>H.02	NS
45	Has mother worked since birth of child?	"No": Lo>Hi	NS	NS	NS				
50	Parent- vs. child-centered activities		NS	NS	$p<.05$	NS	H>L.10	L>H.05	NS

[a] The four variables in this table could not be subjected to analysis of variance because their codes did not even roughly approximate interval scaling. However, it was appropriate to set the data into contingency tables and partition the degrees of freedom (Winer, 1962, pp. 629-632).

[b] In the Prediction column, the entries show which response was expected more frequently of which RAT group; e.g., for Var. 13, it was predicted that Hi RATs' mothers would respond "yes" more frequently than Lo RATs' mothers.

[c] The IQ x C, RAT x C, and IQ x RAT x C columns refer to mutually orthogonal variance components. The IQ x C column shows whether there was a difference between Hi and Lo IQ groups re the keyed response shown in the Prediction column. The RAT x C column shows whether there was a difference between Hi and Lo RAT groups re the keyed response; it is this column which most directly tests the Prediction. The IQ x RAT x C column merely shows whether there was a significant three-way interaction; and if there was, then a "simple effects" analysis was run.

[d] Carried out only if $p(IQ \times RAT \times C) < .20$. The columns show, respectively, differences in C (the criterion variable) between Hi and Lo RATs within the Hi IQ group, between Hi and Lo RATs within the Lo IQ gp, between Hi and Lo IQs within the Hi RAT gp, and between Hi and Lo IQs within the Lo RAT gp. As with the IQ x C and RAT x C entries, the entries in these columns also show which group more frequently gave the keyed response. These columns, however, do not reflect mutually orthogonal variance components.

Certain trends can be seen in these results. The mother and mother-son variables are more important than the father and father-son variables, and parental attempts to control or intrude upon the Ss do not appear to differentiate the High and Low RATs. These trends hold for both the Predicted data (Table 32) and the Non-Predicted data (Table 33).

Low IQ Group. The fathers have come more to the fore: High RATs differ from Low RATs in that the former's fathers have higher education, higher occupational status, and have advanced further beyond their fathers' occupations; however, the groups do not differ in regard to the urban backgrounds of their fathers. They do differ with regard to the urban backgrounds of the mothers: High RATs' mothers had less urban backgrounds, and their families had been in the U.S. for more generations. Also, the geographical stability of High RATs' homes is higher, and High RATs' mothers were much more likely to have worked before their sons' birth.

In regard to the expressed attitudes of the parents toward their children, High RATs' mothers show greater love for their sons, enjoy them more, and find them easier to have around. Further, High RATs' fathers have higher occupational aspirations for their sons, but the groups do not differ in the mothers' aspirations for the boys. The mothers of High RATs, however, in general think more highly of their sons.

The two groups did not differ in age of bladder training, nor did the mothers differ in opinions about when children should be bladder trained; but High RATs' mothers felt that child could not be bladder trained as early as did Low RATs' mothers. In addition, High RATs' toilet training was begun later than low RATs' training. Pre-school teaching was considered less important by High RATs' mothers, and those mothers expressed less respect for their sons' rights to private thoughts. The children, at early ages, did not differ with respect to age of independent activity, concern with responsibility, or whether they had needed help with their problems. High RATs' mothers, though, had been less concerned about their sons' sleeping out (as youngsters) than had Low RATs' mothers.

The contemporary data revealed that High RATs' mothers placed more restrictions on their sons, and yet they allowed them to question authority to a greater extent and more frequently included them in family decisions. Other variables dealing with concern about controlling the child's behavior or actually attempting to intrude into or control the child's activities did not differentiate the groups. There were no differences in punitiveness, child- vs. mother-centeredness of the home, or in the mother's preference for reward and discussion vs. force. The children did not differ in either deportment or independence. However, the High RATs were reported to manifest less guilt after misbehaving than were the Low RATs (this difference did not occur in the early and developmental history data).

The parents of the two groups were not different in their achievement demands, nor in their reactions to underachievement by their children. The mothers of the High RATs more frequently said that the child had arrived at a convenient time, but there were no differences in emotional disturbances or delinquency of the boys, nor in the degree of mother-father disagreements.

Perhaps the most striking pattern of differences centered about the affectional quality of the child's relations with his parents and his self esteem. Although the groups did not differ in regard to the time spent by the child with either or both of his parents, the relations of the High RAT boys with both their mothers and their fathers were significantly closer and smoother. Moreover, High RATs had been more affectionate than Low RATs as youngsters, and High RATs' mothers experienced less conflict about their roles and stood out as being much more likely to participate in joint activities with their sons. Finally, both Hi RATs and their mothers have higher self esteem (and behave like it) and the boys have lower need Achievement and do not differ from Low RATs in manifest anxiety; however, surprisingly enough, the High RAT boys less frequently spoke out against an erroneous majority.

The trends in these data suggest that fathers have taken on somewhat greater importance in differentiating High from Low RATs than they had in the High IQ group, although mothers are still the dominant influence. Furthermore, mothers and sons appear to have been closer among the High RATs' and the High and Low RATs do not differ in their parents' attempts to control them or intrude into their activities. These trends appear in both the Predicted and Non-Predicted data.

Some interesting differences in the numbers of significant differences occurred between the High and Low IQ groups, too. In the High IQ group, High and Low RATs differed on 21% of the ninety-seven variables, but in the Low IQ group High and Low RATs differed on 38% of the variables. (This difference also appeared in the Phase I study.) The greater number of differences within the Low IQ group stemmed from parent interview data regarding childrearing practices and experiences, especially topics dealing with the early and developmental history of the child.

Looking at only the fifty-four variables for which predictions were made, within the High IQ group there were ten significant differences between High and Low RATs. Eight of these ten differences were in the predicted direction (80%). In the Low IQ group, there were sixteen significant differences of which only nine (56%) were as predicted. In addition, only two variables showed significant differences in both the High and the Low IQ groups, and only one of these two was in the predicted direction. Finally, two other variables which showed significant differences within each of the two IQ groups showed opposite directions in the High and Low IQ groups; and the direction shown by these variables in the High IQ group was the predicted one. Thus, different patterns of differences between High and Low RATs are being reflected in the High and the Low IQ groups; and the predictions which were made conformed more closely to the High IQ group's pattern, more variables differentiated the RAT subgroups within the Low IQ control group than within the High IQ group.

Relation between RAT Performance and Intelligence

The obvious need to control intelligence in these analyses necessitated a careful examination of the attempts to implement such control. This examination in turn led to some clear inferences regarding the relations between intelligence and creative potential as measured by the RAT. The RAT clearly is a verbal test; regardless of the assumed intervening processes, it presents verbal stimuli and requires verbal performance responses. RAT scores correlated positively with performances on general intelligence tests, usually from $\underline{r}=.40$ to $\underline{r}=.50$ (Table 35). A question legitimately can be raised as to whether the RAT measures poorly what intelligence tests measure better.

It is suggested that the RAT is not a measure of intelligence, but rather that a moderately high level of intelligence is a necessary prerequisite for High RAT performance. When 2,126 high school students were given an early form of the RAT, their scores correlated .56 with their scores on the Henmon-Nelson general intelligence test; but when the correlation was computed separately for only those Ss with IQ scores above 110, the correlation dropped to .26. The drop may have been due to a truncation of range, although this is not likely in view of the validity data on the RAT which show divergencies between RAT scores and various intelligence test scores when the correlation of each with a performance criterion is taken (Ginsburg, 1964, Chapter 2; Chapter 3 of this report).

Nevertheless, there had been no direct test of the Mednick's argument prior to the present data, which appear to give full support to their view. Comparing the IQ-RAT relations between the Exploratory (Phase I) sample and the Predictive (Phase II) sample, it was found that the RAT-WISC Verbal correlation was much higher (.49) in the Exploratory than in the Predictive group (.23). Furthermore, the mean WISC Verbal score in Predictive group (118.61) was significantly greater ($p<.01$) than that of the Exploratory group. This can be seen in the bottom row of Table 35.

If the suggestion offered above--that a moderately high level of intelligence is a necessary but not sufficient factor in adequate RAT performance--is correct, the lower correlation in the Predictive sample can be explained by the higher mean intelligence of that sample. This interpretation is supported by the findings in Table 35, which compares

TABLE 35

COMPARISON OF RAT SCORES AND OF WISC VERBAL SCORES
FOR VARIOUS SUBGROUPS OF EXPLORATORY
AND PREDICTIVE SAMPLES (MALES)

Subgroup	RAT Comparison						t	p
	Exploratory			Predictive				
	Mean	SD	(N)	Mean	SD	(N)		
Hi IQ, Hi RAT	14.10	2.43	(29)	14.81	1.76	(11)	1.03	NS
Hi IQ, Lo RAT	7.69	1.69	(13)	8.54	3.69	(11)	.70	NS
Lo IQ, Hi RAT	12.62	1.90	(8)	15.26	1.80	(11)	3.15	<.01
Lo IQ, Lo RAT	6.83	2.52	(29)	9.00	2.59	(11)	2.38	<.05
Total	10.23	4.08	(79)	11.93	4.08	(44)	2.21	<.05

Subgroup	WISC Verbal Comparison						t	p
	Exploratory			Predictive				
	Mean	SD	(N)	Mean	SD	(N)		
Hi IQ, Hi RAT	121.07	5.13	(29)	129.00	7.08	(11)	3.39	<.01
Hi IQ, Lo RAT	121.23	7.17	(13)	127.36	7.00	(11)	2.11	<.05
Lo IQ, Hi RAT	105.00	3.81	(8)	109.18	7.82	(11)	1.54	<.20
Lo IQ, Lo RAT	102.93	8.87	(29)	108.91	5.60	(11)	2.53	<.05
Total	112.81	11.28	(79)	118.61	11.85	(44)	2.65	<.01

both the RAT scores and WISC Verbal scores for various subgroups of the two samples. The subgroups are based on median splits along both variables. It can be seen in Table 35 that the two High IQ, High RAT groups and the two High IQ, Low RAT groups both differ significantly in intelligence. Yet, neither the High IQ, High RAT groups nor the High IQ, Low RAT groups differ in mean RAT scores. This is not the case for the Low IQ, High RAT groups or the Low IQ, Low RAT groups. In both of these latter comparisons, the Predictive Ss are higher than their comparable Exploratory compatriots on both WISC Verbal and RAT. The suggestion that a moderately high level of intelligence is a necessary but not sufficient factor in determining adequate RAT performance is supported. Furthermore, this supports the contention that the lower correlation between RAT and WISC Verbal scores in the Predictive group, relative to the Exploratory group, is due to the higher mean intelligence of the former.

Of course, it is possible that the lower correlation between RAT and WISC Verbal scores in the Predictive group is due to statistical artifacts arising from a restriction in the range of the Predictive group's WISC Verbal scores. The possible influence of restriction of range in the Predictive group was directly assessed by curtailing the range of WISC Verbal scores in the Exploratory group so that it was smaller than that of the Predictive group. The original range of WISC Verbal scores in the Exploratory group was 70-139. Arbitrarily removing Ss yielded the following ranges:

WISC Verbal: 80-139
RAT: 0-19

The corresponding Predictive ranges were:

WISC Verbal: 85-148
RAT: 0-19

The correlation between RAT and WISC Verbal scores for the reduced Exploratory group (N = 160) was .47. This is nearly identical to the correlation for the total group (.49, N = 164) and for the Exploratory males alone (.49, N = 86).

The findings in Table 35 and those reported above can be interpreted as follows: A moderately high level of intelligence is necessary but not sufficient for adequate performance on the RAT, and in the higher ranges of intelligence there is less of an IQ-RAT correlation. This interpretation is based upon the following line of thought: First, curtailment of the WISC Verbal range of the Exploratory distribution to a size which is less than the range of the Predictive group, but where the Exploratory distribution is still lower than that of the Predictive group, yields a RAT-IQ correlation only two points lower than the original correlation and still much larger than the comparable correlation in the Predictive sample. This suggests that the difference in the correlations is not a matter of differences in WISC or RAT ranges.

Second, the comparison of IQ-RAT relations in the subgroups of the two samples implies that the IQ-RAT correlation drops off markedly in the upper ranges of IQ. For the Low IQ, Low RAT subgroups, the Predictive Ss are higher than the Exploratory Ss on both RAT and WISC; and the same holds true for the Low IQ, High RAT subgroups. These findings are consistent with the positive correlation between RAT and WISC scores in the two samples. The High IQ subgroups present a different picture, however. The High IQ, High RAT subgroups of the Predictive and Exploratory samples differ on IQ (the Predictive Ss are higher than the Exploratory Ss), but not on RAT. The same holds true for the High IQ, Low RAT subgroups. These findings would not be expected on the basis of a positive IQ-RAT correlation, leading to the inference of a drop-off in the IQ-RAT correlation in the upper ranges of intelligence. Specifically, having an IQ higher than that of another high IQ person is not condition enough for having a higher RAT score than that other person.

Discussion

Several impressions were gained from the Predictive (Phase II) data. First, the inferential categories generated by the Phase I data and into which the Phase II data were coded did not hold up. Second, the Phase II data raise the possibility of creative potential being innately determined. That is, the differences in parental actions toward High and toward Low RAT children may have been reactions to differences in the children rather than determinants of those differences.

Third, the determinants--or consequences--of high creative potential are different for boys of high and of moderate intelligence, with High and Low RAT boys of moderate intelligence being differentiated by many more variables than those of very high intelligence. There is a vague implication in the data that these differences include a greater concern with middle class norms on the part of the High IQs' mothers, and perhaps less personal security; and a greater sense of security, greater spontaneity, and less concern with standards on the part of the Low IQs' mothers. Since the High and Low IQ groups do not differ in education or occupational status of the parents, it is difficult to understand why these differences appear. Nevertheless, the fact that the determinants or correlates of high creative potential do differ between the two IQ groups is patently clear in the data.

Fourth, mothers appear to be greater influences in determining--or are more influenced by--their sons' level of creative potential than the fathers.

Fifth, there appears to be a greater closeness between High RAT sons and their mothers than between Low RAT sons and their mothers. This does not mean more affectionate contact (in the Low IQ case, it was more affectionate--but in the High IQ case, it was less affectionate), but rather more contact per se. A tenable ramification of this is greater mother-son communication, which could have an understandable effect on creative potential--or which could be an understandable consequence of creative potential. The finding of closer contacts is coupled with the next point.

Sixth, there appears to be a greater openness between the High RATs and their mothers than between the mothers and sons of the Low RAT groups. Whether this is due to a lesser demand for privacy (or perhaps a greater expressive tendency) on the part of High RAT boys is not ascertainable from the data; but there does seem to be a norm of greater openness, of less privacy, in the High RAT families.

These general implications of the Predictive data can be compared against the Exploratory findings. The Exploratory data regarding males also reveal a larger number of differentiating variables within the Low IQ group than within the High IQ group. In the Low IQ group, nine parent interview variables and nine teacher rating rating variables differentiated High and Low RATs; in the High IQ group, seven interview variables and four teacher rating variables differentiated. It seems as though very high intelligence (and both the rewards which accrue to it and the demands it places on others) either compensates for or overrides the manifestation of differences due to high creative potential. For example, very intelligent children will receive many rewards on the basis of their intelligence, regardless of their creative potential, and this should minimize the differences among those children which are consequences of (or determinants of) creative potential.

The Exploratory data indicate greater training in responsible autonomy with respect to High RAT males than Low RAT males in both the High and Low IQ groups, but especially in the High IQ group. The Predictive data appear to repeat this finding in the High IQ group but not in the Low IQ group.

The Exploratory data show greater demands for adequate performance by the sons on the part of the mothers of Low RATs in the Low IQ group. If this concern is internalized by the boys, it parallels the finding in the Predictive study that the Low IQ, Low RAT boys show greater concern with responsibility. However, the difference does not seem particularly germane to a determination of creative potential unless one assumes that the Low IQ, Low RAT group is the most numerous in the population, and that all three of the less frequent groups (High IQ, High RAT; High IQ, Low RAT; Low IQ, High RAT) are characterized by a lesser concern with responsibility.

The greater mother-son closeness and openness indicated by the Predictive study cannot be directly assessed in the Exploratory data. The one indirect reflection of the same tendency in the Exploratory study is the greater readiness of High RATs to admit having misbehaved.

There is no basis in the Exploratory study for evaluating the direction of causality--i.e., for assessing the possibility of innate determination of creative potential.

Finally, there were too few father and father-son variables in the Exploratory study to allow an evaluation of the relative influences of mother and father on creative potential.

So, to the extent that the variables in the Predictive and Exploratory studies overlapped, there was an indication of replication, especially in regard to training in responsible autonomy within the High IQ groups. Also, it is very clear that there are more variables along which High and Low RATs of moderate intelligence differ than High and Low RATs of very high intelligence.

CHAPTER 7

FACTORS AFFECTING THE MANIFESTATION OF CREATIVE ABILITY BY SCIENTISTS[1]

While considerable work has been done in recent years to find ways to measure creative ability and describe the nature and background of "creative" individuals, less information is available about social or psychological factors which influence the manifestation of creative ability.

There is, however, considerable agreement among psychologists that the concept "creativity" involves both something new (or at least rare) and an evaluation of it.

The approach taken in this project defines the creative process as "the forming of associative elements into new combinations which either meet specified requirements or are in some way useful. The more mutually remote the elements of the new combination, the more creative the process or solution."

Maltzman (1960, p. 229) distinguishes originality from creativity as follows: "Originality . . . refers to behavior which occurs relatively infrequently, is uncommon under given conditions, and is relevant to those conditions. . . . Creativity . . . refers to products of such behavior and the reactions of other members of society to those products. . . . Our distinction implies that an individual may be highly original but not creative."

Note that these definitions of creative behavior involve "evaluations" or "reactions" of other people. It follows that a more adequate understanding of creative behavior will result if one considers certain motivational and social psychological variables jointly with the purely psychological variable of "creative ability." Potentially important variables may include: (a) the degree of a person's motivation to use his creative ability, (b) the probability of his deciding to communicate his unusual ideas to others, (c) the adequacy of communication channels available for his use, and (d) the probability that others will accept communications from the sender.

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[1] The author of this chapter is Frank M. Andrews, Institute for Social Research, University of Michigan. It is based on a doctoral dissertation which was co-supervised by S. Mednick and D. Pelz, and is published as a paper in J. Pers., 1965, 33, 140-152.

A formal mathematical model of the creative process seems premature. A first approximation to a model, however, might take the following form:

$$C = f(M \cdot R \cdot D \cdot B \cdot A)$$

Where:

C = probability of ego's producing a creative act which alter accepts as useful

f = a monotonic transposition factor

M = ego's strength of motivation

R = probability of ego's achieving a combination of associative elements which are mutually remote (where "remote" is all points below some designated point on a scale of probabilities with which various elements are associated with a given element)

D = probability of ego's deciding to communicate his combination of remotely-associated elements

B = adequacy of communication channel open to ego ("broadcasting")

A = probability of alter's accepting ego's communicated combination of remotely-associated elements.

One should note that the above set of multiplicative relationships represents an interactive model rather than a simple additive one.[2]

Hypotheses. With respect to the relationship between potential creative ability (R) and creative performance (C), these five hypotheses were derived from the model: (I) the relationship between R and C will be positive. The relationship between creative ability and creative performance will be more strongly positive (or less negative) under conditions of: (II) high motivation (M), or (III) high probability of ego's deciding to communicate his remote associations (D), or (IV) adequate communication channels (B), or (V) high probability of alter's accepting ego's communications (A). These hypotheses were expected to be true only for creative performance. Performance of the "restructuring" scientists (described below) was expected to be of a more creative nature than that of the "accumulators."

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[2] In a provocative paper, Shockley (1957) suggested that the differences among scientists' performance are much larger than the differences among trained people in many other endeavors. He demonstrated that the tremendous variation in scientific performance, and its lognormal distribution, could be obtained by small variations in a limited number of multiplicative factors. While his data applied only to output of scientific publications, this was one instance in which a multiplicative model seemed to describe a creative phenomenon.

While there is considerable indirect support in the literature for the importance of each of these factors, their direct relevance to the consideration of creativity has rarely been rigorously demonstrated. The reader is referred to Andrews (1962) for a survey of the relevant literature.

Method

The hypotheses above are in terms sufficiently general to be applicable to a wide variety of creative activity. One such activity, it is commonly believed, is conducting original research.

All of science is not necessarily creative, and even the most creative scientists probably spend much time in the routine activities of collecting data and making computations. Nevertheless, it seems reasonable to believe that some scientists spend more time "restructuring knowledge" than others. Data on these people would have high relevance to the study of creativity.

Subjects

Between 1958 and 1960, 1,311 scientists and engineers provided responses to a wide variety of questionnaire items inquiring about their work, laboratory organization, interaction with colleagues and supervisors, motivations, family and professional background, and amount of scientific output.[3]

Scientists who answered the questionnaire were located at eleven different sites. These were: a large mid-western university; five industrial organizations engaged in the manufacture of glass, drugs, or electronic devices; and five governmental laboratories doing basic, military, or biological research.

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[3] These data derive from a continuing project at the Institute for Social Research on motivations and working relations of scientists and engineers, of which Donald C. Pelz is the director. A copy of the questionnaire is available in Andrews (1962).

The sample was not selected so as to be representative of all scientists.

Nearly all these scientists had at least a bachelor's degree; 41% of them had a PhD; their median annual income was $9,700. Nevertheless, most of these people were working with people and for people. They rarely could be oblivious of the others around them. They rarely could act with the almost complete independence society accords to the recognized genius.

Thus this sample--particularly the restructurers in it (described below)--seemed appropriate for testing the above hypotheses.

Measures

Creative Ability. During the fall of 1961, the writer gave 355 of these scientists[4] the RAT.

Scientific Performance. Measures of scientific performance were derived from two sources. The first was the scientist's own reports of his five-year output of patents, papers, and unpublished reports. The second was judgments of each respondent's performance by peers and supervisors who felt knowledgeable about the man's work. Judgments were made with respect to the man's scientific or technical contribution and (separately) his overall usefulness to the organization.[5]

The self-reported outputs were transformed to log scores to produce more nearly normal distributions,[6] and the evaluations were converted to percentile scores (within site).[7] All scores were then adjusted (separately for each of the four relatively homogeneous "primary groups" in the sample)[8] to hold constant four background effects which it seemed advisable to partial out: education, length of work experience, type of research setting, and time between BS and PhD or age at BS. These four factors, taken together, accounted for 7 to 25 per cent of the variances in the unadjusted scores, the exact value varying from group to group and measure to measure.

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[4] Full questionnaire data were available for 214 of these scientists; others had answered a "short form" of the questionnaire.

[5] Details of the judging technique and copies of the instructions to judges are described in Andrews (1962).

[6] This replicated a finding by Shockley (1957) that the output of scientific products was lognormally distributed.

[7] A computer program was used, based on a technique by Ford (1957).

[8] These four primary groups were as follows: (I) PhD's working in research labs (N=205); (II) PhD's working in development labs (N=183); (III) Non-PhD's working in labs having many (42% to 52%) PhD's (N=234); These were called "assistant scientists"; (IV) Non-PhD's working in labs

Intercorrelations (obtained separately for each primary group) among the adjusted log output measures and between these measures and the adjusted evaluations were all low positive (median $\underline{r}$ = .19, range = .05 to .38). The intercorrelations between the two adjusted evaluations ranged from .55 to .71 across the four primary groups (median $\underline{r}$ = .64).

Independent Variables. The independent variables described below were all based on indices. The general approach was to cull from the questionnaire all items which, on an a priori basis, promised to be useful for measuring a given factor. Intercorrelations among these items were obtained separately for each of the four primary groups. Items in clusters which could be matched across the resulting four matrices were then combined into the desired index. In combining, items were weighted so each item contributed approximately equally to the total variance of the index. Full details for each index are available in Andrews (1962).

The measure of motivation strength was based on a cluster consisting of the following five items: the respondent's sense of involvement in his work; his interest or excitement in his work; his identification with his most important project; the importance of his work; and the challenge of his work (median $\underline{r}$ = .46; range = .07 to .70).

The probability of ego's deciding to communicate his unusual ideas to others was measured indirectly by the influence the respondent had in his research environment. It was reasoned that influential respondents would be more secure and face lower risks (compared with those less influential) if they put forth potentially disturbing or disrupting ideas. Influence was determined by a two-item index: the respondent's estimate of his influence of the person having most weight (a) in setting the respondent's work goals and (b) in decisions about the respondent's resources or funds (median $\underline{r}$ = .50; range = .36 to .52).

The adequacy of available communication channels was measured by a four-item index. These items were: number of people with whom the respondent exchanged detailed information; mean coordination of activities between the respondent and each of five colleagues; frequency of communication between the respondent and his administrative chief; and mean frequency of communication between the respondent and each of his five colleagues (median $\underline{r}$ = .31; range = .16 to .60).

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having few (less than 20%) PhD's (N=668). Those in research labs were called "non-PhD research scientists"; those in development, "engineers." (The characterization of a department as research or development oriented was based on an index of six items concerned with whether executives were believed to stress production of products or knowledge.)

The probability that others would accept communications from the respondent was indirectly measured by the respondent's *status* in the laboratory. Other things equal, communications from people with high status were expected to be more acceptable than communications from low status people. Data by Torrance (1955) supported this. Status was measured by an index consisting of these three items: length of time the respondent had been in his technical division; number of people officially reporting to the respondent or his subordinates; the respondent's annual income (median r, based on coded values = 48; range = .28 to .74).

A Control Variable. Creative ability was not expected to be equally relevant to all forms of scientific endeavor, nor were the hypotheses of the study expected to apply to all groups of scientists. Some scientific work can be regarded as primarily accumulating data, whereas other research consists of finding new relationships among data already at hand--i.e., restructuring knowledge. It was to the latter type of activity that creative ability (and our hypotheses) were believed to be relevant.

Unfortunately, no way was found, in the data available, to determine the extent to which a respondent's *job* was accumulating or restructuring. However, after examining intercorrelations[9] among twenty variables from the questionnaire which might indicate a difference in *preference* or *self conception*, a cluster of four items was selected. These were: the extent the respondent preferred to map broad features of important new areas, leaving detailed study to others; his self estimated creativity; his estimates of the usefulness of his original ideas to his colleagues; and his lack of methodicalness (median r = .33, range = .12 to .48).

Scientists who got high scores on this index--i.e., those seeing themselves as relatively high in creativity, useful to colleagues in providing original ideas, preferring to map broad features of new areas, and lacking in methodicalness--were called "restructurers"; those having opposite characteristics, "accumulators."

An examination of various characteristics of scientists who differed on the accumulate-restructure index indicated some differences in roles. It was found that restructurers were more likely than accumulators to: (a) occupy supervisory roles ($p < .001$); (b) be a PhD in a research or development lab, or an engineer, rather than an assistant scientist or non-PhD research scientist[10] ($p < .001$); (c) be doing general research or development rather than specific research or service ($p < .20$).

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[9] Intercorrelations were run separately for scientists in research-oriented and development-oriented laboratories (see footnote 8).

[10] Footnote 8 describes these groups.

For purposes of analysis, this index was approximately trichotomized to form the restructuring, middle, and accumulating groups.

Interrelationships Among Independent and Control Variables

The intercorrelations among the independent and control variables were examined. (Kendall's [1955] tau_c was used since some indices had skewed distributions.) RAT scores were virtually independent of all other measures (median tau_c = .05, range = -.06 to -.02). Relationships among all other variables (including the accumulate-restructure index) were low positive (median tau_c = .17; range = .04 to .29).

Results

Correlations between RAT and Performance. Correlations between RAT scores and the measures of performance, both before and after adjusting, were computed separately for scientists in the restructuring, middle, and accumulating groups. They are shown in Table 36.

Results were clear. Creative ability, as measured by the RAT, showed no strong relationship to any of the measures of scientific performance for any of the three groups. Adjusting the performance measures to hold constant various background effects--differences in education, length of work experience, type of research setting, and time between BS and PhD or age at BS--had little effect on the relationships. The only trend which did appear indicated a slight negative relationship between RAT score and each performance measure for the restructurers (contrary to the prediction of Hypothesis I).

Of the thirty correlation coefficients shown in Table 36, only two were statistically significant at the .05 level. One was positive, one was negative, and both occurred for the accumulators. One must conclude that in this sample RAT scores, taken alone, were not good predictors of scientific performance. Hence Hypothesis I was not supported.

Correlations Between RAT and Performance, Holding Social Psychological Variables Constant

Motivation. Table 37 repeats the data for Table 36 for the two performance measures based on evaluations and introduces a control for strength of motivation (M). A clear main effect was evident. Mean contribution and usefulness were higher for scientists with high motivation than those with low. The trend appeared in all six cells; it reached statistical significance ($p < .05$) in three. The interaction effect

TABLE 36

CORRELATIONS BETWEEN RAT SCORES AND MEASURES OF SCIENTIFIC PERFORMANCE BY ACCUMULATE-RESTRUCTURE INDEX

(Based on 83 accumulators, 46 scientists in the middle group, and 85 restructurers)

Variables correlated	Group	Correlation	
		Unadjusted measures	Adjusted[a] measures
Log patents and RAT	Restructurers	-.12	-.12
	Middle	.00	.07
	Accumulators	.18	.18
Log papers and RAT	Restructurers	-.06	-.06
	Middle	.09	.13
	Accumulators	.09	.24*
Log reports and RAT	Restructurers	-.09	-.06
	Middle	.18	.17
	Accumulators	-.25*	-.17
Scientific contribution and RAT	Restructurers	-.15	-.18
	Middle	.09	.08
	Accumulators	-.02	.09
General usefulness and RAT	Restructurers	-.19	-.19
	Middle	.02	-.06
	Accumulators	-.07	.01

*$p < .05$ (two-tailed).

[a] The performance measures were adjusted to hold constant differences due to education, length of work experience, type of research setting, and time between BS and PhD or age at BS.

TABLE 37

MEAN EVALUATED PERFORMANCE, AND CORRELATIONS BETWEEN RAT AND PERFORMANCE, BY ACCUMULATE-RESTRUCTURE INDEX AND BY MOTIVATION

Accumulate-restructure index	Motivation	N	Adjusted scientific contribution		Adjusted usefulness	
			Mean	Corr. with RAT	Mean	Corr. with RAT
Restructurers	Low	26	49.8┐	-.15	48.5┐	-.02
	High	55	62.5┘	-.15	65.3┘	-.20
Middle	Low	22	47.9	.19	47.5	.12
	High	22	63.9	-.11	60.8	-.26
Accumulators	Low	45	40.7	.23	40.8┐	.12
	High	38	46.1	-.05	54.0┘	-.04

Note: A line connecting two means indicates the difference between them is statistically significant beyond the .05 level (two-tailed).

predicted by Hypothesis II, however, did not appear; if anything, the relationship between RAT and performance was slightly less positive under conditions of high motivation than under low. Hypothesis II, therefore, was not supported.

Influence. Table 38 shows the results when influence was held constant. As in Table 37, a main effect was clearly evident. Performance was consistently higher for the high influence group. The differences were significant in four out of the six cells. This came as no surprise. One could argue that scientists were given more influence because they performed better. On the other hand, influence may have enabled scientists to perform better. The direction of causality remains to be determined.

Striking results appeared, however, when the relationships between RAT and performance were examined. Note that for the restructurers having low influence there was a negative correlation between RAT and both performance measures (r = -.44 and -.47; $p < .05$). For those with high influence, however, these variables were virtually independent (r = -.01 for both measures). The difference between the two correlations was statistically significant beyond the .05 level for both performance measures. Hypothesis III, therefore, was supported.

For the accumulators, the opposite pattern occurred. The middle group showed a pattern intermediate between that for the accumulators and restructurers. None of the correlations between RAT and performance reached statistical significance for the accumulators or middle group. Since creative ability was expected to be less relevant for these groups than for the restructurers, this was in line with expectation.

Communication. A striking pattern, similar to that shown in Table 38 also appeared when the index of adequacy of communication channels was held constant (see Table 39). In five of the six cells, a main effect was evident--higher performance was associated with high adequacy of communication channels. For restructurers having low adequacy of communication, the correlations between RAT and both measures of performance were negative (r = -.32 and -.35; $p < .05$); for restructurers with high adequacy of communication, the correlations were virtually zero. While the trend clearly supported Hypothesis IV, the differences between correlations did not reach the .05 level of significance with the number of cases available.

For the accumulators, RAT was almost independent of performance (as expected), regardless of adequacy of communication. The middle group showed a pattern intermediate between the restructurers and the accumulators.

Status. When the probability of others' accepting communications sent by ego (as measured by the scientist's status) was held constant, the same pattern again appeared (Table 40). A main effect between

TABLE 38

MEAN EVALUATED PERFORMANCE, AND CORRELATIONS BETWEEN RAT AND PERFORMANCE, BY ACCUMULATE-RESTRUCTURE INDEX AND BY INFLUENCE

Accumulate-restructure index	Influence	N	Adjusted scientific contribution		Adjusted usefulness	
			Mean	Corr. with RAT	Mean	Corr. with RAT
Restructurers	Low	32	51.9	-.44*	50.9	-.47*
	High	52	64.1	-.01	64.9	-.01
Middle	Low	23	53.8	.05	48.9	-.03
	High	20	58.7	.09	60.8	-.06
Accumulators	Low	48	37.1	.24	40.1	.27
	High	29	53.6	-.18	58.7	-.27

*$p < .05$ (two-tailed).

Note: A line connecting two means or two correlations indicates the difference between them is statistically significant beyond the .05 level. One-tailed tests were used where predictions were made (i.e., between correlations for restructurers); two-tailed tests were used elsewhere.

TABLE 39

MEAN EVALUATED PERFORMANCE, AND CORRELATIONS BETWEEN RAT AND PERFORMANCE, BY ACCUMULATE-RESTRUCTURE INDEX AND BY ADEQUACY OF COMMUNICATION CHANNELS

			Adjusted scientific contribution		Adjusted usefulness	
Accumulate-restructure index	Adequacy of communication channels	N	Mean	Corr. with RAT	Mean	Corr. with RAT
Restructurers	Low	37	59.0	-.32*	54.9	-.35*
	High	45	58.9	-.04	63.1	.01
Middle	Low	23	54.3	-.01	48.7	-.18
	High	21	59.2	.13	59.3	.13
Accumulators	Low	43	38.3	.01	38.4	-.08
	High	39	49.6	.10	58.2	-.02

*$p < .05$ (two-tailed).

Note: A line connecting two means indicates the difference between them is statistically significant beyond the .05 level (two-tailed).

TABLE 40

MEAN EVALUATED PERFORMANCE, AND CORRELATIONS BETWEEN RAT AND PERFORMANCE, BY ACCUMULATE-RESTRUCTURE INDEX, AND BY STATUS

Accumulate-restructure index	Status	N	Adjusted scientific contribution		Adjusted usefulness	
			Mean	Corr. with RAT	Mean	Corr. with RAT
Restructurers	Low	39	50.8 ┐	-.36* ┐	49.8 ┐	-.36* ┐
	High	46	67.3 ┘	.01 ┘	68.3 ┘	.01 ┘
Middle	Low	30	51.5	.13	48.2 ┐	-.02
	High	15	63.2	-.04	64.6 ┘	-.02
Accumulators	Low	57	37.6 ┐	.24	35.9 ┐	.13
	High	26	55.2 ┘	-.12	70.3 ┘	-.14

*$p < .05$ (two-tailed).

Note: A line connecting two means or two correlations indicates the difference between them is statistically significant beyond the .05 level. One-tailed tests were used where predictions were made (i.e., between correlations for restructurers); two-tailed tests were used elsewhere.

status and performance was evident (not surprisingly), and the restructurers with high status showed a significantly more positive correlation between RAT and performance ($\underline{r}$ = .01 for both measures) than those with low status ($\underline{r}$ = -.36 for both measures). Thus Hypothesis V was supported.

Effects of Influence on the Relationship between RAT and Scientific Performance

Objective Performance Data. Analyses described in the previous section were carried out for two evaluations of scientific performance. It was important to know whether the findings for evaluations also applied to objective measures of scientific performance.

The reader will recall that three objective performance measures were collected from each respondent: his output, over the preceding five years, of patents, papers, and unpublished reports. Papers seemed an appropriate measure for primary groups I, II, and III, and reports was appropriate for primary group IV.[11]

Since differences in influence produced the strongest effects on the relationship between RAT and evaluated performance, this variable was used in the analysis of the objective performance measures. Results are shown in Table 41.

One may note that both the paper and report measures showed the same pattern of correlations as was found in Table 38. The significant finding was that restructurers who were low in influence, and who had high RAT scores, had lower output than those who had lower RAT scores. This was further evidence in support of Hypothesis III. (However, the pattern of differences between the pairs of means shown in Table 38 was not generally replicated with respect to output. The one significant difference was in the expected direction.)

Discussion

These findings, which supported Hypotheses III, IV, and V, showed that certain social psychological variables affected the manifestation of creative ability by scientists who preferred "restructuring" types of jobs. When social psychological variables were not considered, creative ability (as measured by the RAT) showed no relationship to any measure of scientific performance for any of the three groups of scientists (i.e., Hypothesis I was not supported). These results suggest that the nature of the environment should be a part of any theory of creative behavior.

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[11] Footnote 8 describes these groups.

TABLE 41

MEAN OBJECTIVE PERFORMANCE, AND CORRELATIONS BETWEEN RAT AND PERFORMANCE, BY ACCUMULATE-RESTRUCTURE INDEX, AND BY INFLUENCE

		Adjusted log papers, Primary Groups I-III			Adjusted log reports, Primary Group IV		
Accumulate-restructure index	Influence	N	Mean	Corr. with RAT	N	Mean	Corr. with RAT
Restructurers	Low	20	4.2	-.31	12	3.2	-.65*
	High	32	4.0	.13	20	4.1	-.05
Middle	Low	15	4.2	-.07	8	4.2	-.06
	High	8	4.2	.27	12	3.8	.44
Accumulators	Low	31	3.5	.10	15	3.5	-.13
	High	15	3.9	-.02	14	3.5	-.16

*$p < .05$ (two-tailed).

Note: A line connecting two means or two correlations indicates the difference between them is statistically significant beyond the .05 level. One-tailed tests were used where predictions were made (i.e., between correlations for restructurers); two-tailed tests were made elsewhere.

The direction of the statistically significant relationships reported herein (all negative) casts new light on the effects of high creative ability (insofar as this is measured by the RAT). Creative ability, it appears, is not something which may be "on" or "off"; rather, high creative ability is always "on," but may result in lowered performance if requisites for its proper use are not present. High creative ability might be likened to a hardy seed, which yields blossoms when sown on fertile ground, but only thorns when falling on infertile ground. It was the scientists in restrictive situations (low influence, low communication, or low status) who tended to manifest their creative ability in the form of thorns.

The lack of significant positive relationships between RAT scores and scientific performance in these data caused concern. Could it be that the RAT was not measuring a form of creative ability which was useful for scientists? Perhaps, though Mednick's (1962) demonstration of validity for a group of psychology graduate students made this explanation unlikely.

Could it be that the laboratories studied simply did not make good use of the creative ability of their scientists? This, too, was possible, reminding one of Getzels and Jackson's (1962) conclusion that school teachers tended not to reward their more creative students who had only average intelligence.

A third possibility was that the group of scientists who operated in a favorable environment (and for whom one would expect a positive relationship between creative ability and performance) had not been separately identified. In an effort to locate such a group, the data were submitted to a computer program specially designed to detect interactions.[12] For the accumulators (who were combined with the middle group), no consistent relationships between RAT and scientific contribution occurred (as expected). For the restructurers, however, a suggestive lead emerged for a small group (N = 14): for those restructurers who were simultaneously high in status, self-confidence,[13] influence, and motivation, there was a positive relationship between RAT and contribution equivalent to a biserial $\underline{r} = .37$. Based on only fourteen cases, and without having been replicated, this lead was only suggestive. It implied, however, that there may indeed be a set of social psychological variables which, when simultaneously present, will enhance the manifestation of creative ability. Considerable further research will be required to identify the particular characteristics of situations in which high creative ability is manifested in the form of accepted and useful innovations.

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[12] The program seeks that division of an independent variable which, when the group is split into two subgroups, would produce the greatest reduction in the unexplained sum of squares of a dependent variable. The program examines all possible splits of all independent variables. After making the first split, the operation is repeated for each subgroup separately. Groups continue to be split until some predetermined criterion is reached. Full details are available in Morgan and Sonquist (1963).

[13] This was another attempt at measuring the probability of a scientist's deciding to communicate his unusual ideas. The index was constructed in the same manner as indices described previously and was based on self-estimates of three abilities: technical, creative, and critical.

CHAPTER 8

INTER- AND INTRA-HIERARCHY ASSOCIATIVE RELATEDNESS IN VERBAL TRANSFER[1]

Garskof, Houston, and Ehrlich (1963) have suggested that word-association strength and associative overlap are two distinct associative-relatedness variables which operate independently in verbal behavior. Word-association strength or Intra-hierarchy relatedness (Intra-HR) refers to the strength of the connection between a word and an associate to that word. This strength may be estimated from group frequencies (Russell and Jenkins, 1954), latency (Schlosberg and Heineman, 1950), or rank order of emission (Rosen and Russell, 1959). Associative overlap or Inter-hierarchy relatedness (Inter-HR) refers to the degree to which two words elicit the same associates. Several measures of associative overlap have been developed (Bousfield, Whitmarsh and Berkowitz, 1960; Cofer, 1957; Deese, 1962, Gerskof and Houston, 1963a).

Inter-HR may include, in part, Intra-HR strength. Each measure of Inter-HR mentioned above includes the stimulus word in the associative hierarchy. Thus, if there is any Intra-HR between members of a word pair A-B, the list of shared associates would include either the pair A-A or B-B, or both. These pairs would enter into the estimation of the Inter-HR between A-B.

Although for some word pairs Intra-HR influences the size of the estimate of Inter-HR, the two associative-relatedness variables are independent behaviorally (Garskof, Houston, and Ehrlich, 1963).

Recently Garskof and Houston (1963b) have found that judged similarity is highly related to Inter-HR with the effects of Intra-HR partialled out, but that judged similarity is not related to Intra-HR with the effects of Inter-HR partialled out. This finding suggests that studies which have demonstrated a relationship between judged similarity in meaning and amount of verbal transfer (Gladis and Braun, 1958; Morgan and Underwood, 1950; Postman, 1962; Underwood, 1951; Young, 1955) may have demonstrated a relationship between Inter-HR and verbal transfer. However, another group of studies (Bastian, 1961; Buzzotta, 1956; Carlin, 1959; Ryan, 1960) have shown that verbal transfer relates to the degree of Intra-HR. Since neither set of studies juxtaposed the alternate relatedness variable, it is impossible to state, based on the existing literature, whether verbal transfer is a function of Inter- or Intra-HR or a joint function of both. The present study was designed to investigate these alternate possibilities.

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[1] Written by B. E. Garskof and published in J. Verb. Learn. Verb. Behav., 1964, 3, 460-465. The author is now at Rutgers--The State University, New Brunswick, New Jersey. This represents a portion of a dissertation directed by S. Mednick.

Two experiments will be reported. In each of them a set of word pairs was employed which conformed to the following conditions: high Inter-HR--high Intra-HR, high Inter-HR--low Intra-HR, low Inter-HR--high Intra-HR, low Inter-HR--low Intra-HR, zero Inter-HR--zero Intra-HR. Experiment I tested the above conditions in the chaining paradigm (A-B, B-C, A-C). Experiment II tested the same set of A-B conditions in a response equivalence paradigm (A-B, C-A, C-B). A mixed list design was adopted so that each S received learning lists containing the word pairs representing the five A-B relationships.

Method

Experimental Lists. Fifteen A-B word pairs were employed in the transfer experiments to be reported. The Intra- and Inter-HR strengths of the pairs were estimated prior to the experiments.

The Inter-HR values of thirty word pairs were estimated by a method described in Gerskof and Houston (1963a). In this measure, termed the Relatedness Coefficient (R.C.), the Inter-HR between two words is expressed as the ratio of the sum of the cross products of the ranks of the common hierarchical words to the sum of the squares of the ranks of the larger hierarchy.

Twenty undergraduate Ss served in the continued association task to gather the normative R.C. data. The stimulus word list consisted of sixty words. These words were all either AA or A words in the Thorndike-Lorge Word Count (1944).

Sixty-page booklets were prepared for the continuous word association task. On each page in the booklet one of the stimulus words was listed fifty times followed each time by a blank space. The sixty pages in each booklet were collated in a random order assigned by a table of random numbers so that each S received a different order of stimuli. The Ss were tested in a group. They were instructed to associate to each stimulus word repeatedly for one minute. The R.C.'s of the thirty-word pairs were computed and averaged across the twenty Ss.

The Intra-HR values for the same 30 word pairs were estimated through the use of the standard word-association task. Forty-five undergraduate *S*s associated to the thirty A members of the A-B pairs, and a second group of forty-five *S*s received the B words as their association stimuli. To reduce order effects, four random orders of the list were constructed. The second stimulus-word list was constructed in the identical manner except that the B words served as stimuli. The ninety *S*s were tested in a group. The four orders of both A and B sheets were distributed alternately to the seated *S*s. The *S*s were instructed to associate once to each word on their list. The proportion of *S*s who gave B as a response to each A word was tabulated as was the proportion of *S*s who responded to each B word with the corresponding A word. In addition, the proportion of the total group of ninety *S*s who gave either A to B or B to A for each A-B pair was tabulated. It must be pointed out that the number of *S*s used to gather Intra-HR values was insufficient to produce stable normative data. It was, however, large enough to yield data which allowed for the gross distinction, made in the study, between high and low Intra-HR pairs.

Based on the results of the preceding studies, fifteen word pairs were chosen to serve as A-B experimental pairs. The fifteen pairs were chosen so that an experimental list could be developed which tested verbal transfer under the five different A-B relationships mentioned earlier. Table 42 presents the mean Inter- and Intra-HR values for the three pairs in each A-B relationship group. Inter-HR values appear in the column headed by R.C. Intra-HR values are listed as follows: the proportion of Bs given to A is listed as A-B, the proportion of As given to B is listed as B-A, the proportion of As to B plus Bs to A is listed as A-B + B-A.

TABLE 42

MEAN NORMATIVE INTRA-HR, INTER-HR VALUES
FOR THE FIVE RELATIONAL SUBGROUPS

Relation Groups	Mean Values			
	A-B	B-A	A-B + B-A	R.C.
High Inter-High Intra	.311	.121	.218	.361
Low Inter-High Intra	.333	.053	.196	.182
High Inter-Low Intra	.094	.098	.096	.344
Low Inter-Low Intra	.096	.014	.055	.185
Zero Inter-Zero Intra	000	000	000	000

Fifteen low association-value two-digit numbers (Bettig and Spera, 1962) served as C terms. These were chosen to minimize pre-experimental C-A or C-B associations. Three sets of B-C, A-C or C-A, C-B lists were constructed. Each set paired each A-B pair with a different C term.

To control serial position effects, five arrangements of each set of (A-B)-C pairings were constructed such that over groups of five Ss, each B-C, A-C or C-A, C-B item would be represented once in each list position. Three random orders of B-C, A-C or C-A, C-B pairs were used to minimize serial learning of responses.

Subjects. The Ss were thirty male and thirty female undergraduates enrolled in elementary psychology courses. Participation in the experiment was a course requirement.

Materials. The list requirements necessitated the construction of fifteen experimental lists for each of the two paradigms to be tested. The thirty lists were typed on heavy vallum memory-drum paper in upper case pica letters.

Apparatus. Experimental lists were presented on a Stowe memory drum, Model 4598, mounted on a 3 x 4 ft. black wooden screen which hid E from S's view.

Procedure. The sixty Ss were assigned to an experiment and to a particular list randomly prior to the experiment. The assignment was done so that one male and one female were assigned to each of the five lists in each set of (A-B)-C pairings. A 2:2 anticipation interval was employed in each experiment. The Ss were read standard paired-associate anticipation instructions. Each S learned each of two lists to the criterion of one perfect anticipation of the fifteen-item list. Second-list learning was begun immediately after criterion was reached on the first list. The Ss were told that they were to learn two lists.

Results and Discussion

Experiment I. Table 43 presents the basic acquisition data for Experiment I. To adjust for the possible effect of inequalities in degree of second-stage learning on third-stage learning, two measures of transfer were developed so that the degree of second-stage learning of each item for each S entered into the measures of transfer. The first measure was used to analyze the effects of the A-B relationships over the total course of third-stage learning. The second measured the effects of the various A-B relationships in the initial trial of the third-stage list.

In the first measure for each of the five A-B relationships, the mean proportion of correct anticipations in the second-stage list was subtracted from the proportion of correct anticipations found for the

TABLE 43

BASIC ACQUISITION DATA: STAGE-2 AND STAGE-3 LEARNING (EXP. I)

Score		Relation				
		High Inter-High Intra	High Inter-Low Intra	Low Inter-High Intra	Low Inter-Low Intra	0 Inter-0 Intra
Total correct anticipations	$\bar{X}$	38.50	51.26	38.76	41.63	34.73
Stage-2	S.D.	16.75	18.87	17.23	20.72	14.73
Total correct anticipations	$\bar{X}$	25.37	29.77	22.77	21.87	18.03
Stage-3	S.D.	12.05	13.20	9.53	9.70	10.66
No. correct anticipations first two trials	$\bar{X}$	3.13	3.83	2.17	1.63	0.70
Stage-3	S.D.	1.77	2.03	1.42	1.78	0.86
Stage-2	$\bar{X}$	28.13				
Trials to criterion	S.D.	9.15				
Stage-3	$\bar{X}$	12.23				
Trials to criterion	S.D.	5.66				

same S and A-B relationship in the third-stage list. In the second measure, for each of the five A-B groups of word pairs, the mean difference was calculated between the proportion of correct anticipations in the first two anticipation trials of Stage-3 learning and the total proportion of correct anticipations found for that same set of A-B items in Stage-2 learning. The mean transfer values for each A-B relationship are listed in Table 44 for both transfer measures. These derived transfer data may be used only if a relationship can be shown between degree of Stage-2 and degree of Stage-3 learning within the A-B groups. This relationship was investigated in the following way. The three items within each A-B group were ranked in terms of the number of correct anticipations attained in both Stage-2 and Stage-3. The extent to which the rankings were the same for the two stages was taken as a rough measure of the effect of Stage-2 practice on Stage-3 performance within the various A-B groups. For three of the A-B groups examined, the rankings were identical. For the remaining A-B groups, one item was misplaced in the rankings. Although the relationship between learning of the two stages was not perfect for all A-B groups, there seemed to be sufficient correspondence to permit the further analysis of the derived transfer data.

Two sets of statistical procedures were applied to the values from each transfer measure. The first procedure tested the effects of the two levels of each relational variable and their interaction. The second procedure tested the differences between the transfer found with each of the four A-B relations and the transfer found with A-B pairs having no pre-experimental relationships.

TABLE 44

MEAN TRANSFER VALUES FOR EACH A-B GROUP
OF WORD PAIRS (EXP. I)

(3rd stage--2nd stage)

Score	Relation				
	High Inter-High Intra	High Inter-Low Intra	Low Inter-High Intra	Low Inter-Low Intra	0 Inter-0 Intra
Transfer Measure 1	+.268	+.221	+.194	+.154	+.058
Transfer Measure 2	+.058	+.043	-.104	-.202	-.300

An analysis of variance was performed upon the values computed with the first transfer measure. Inter-HR was a significant main effect ($\underline{F}$ = 18.57, $\underline{df}$ = 1, 29, $\underline{p} < .05$). Neither Intra-HR nor the interaction between the two relationships was a significant source of variance ($\underline{F}$ = 1.96 and 0, respectively).

To compare the transfer values for each of the four A-B relational groups with that found with the zero-zero A-B words, a significant $\underline{F}$ had to be shown for the five A-B groups. The effect of A-B groups was tested with a treatments x subjects design and yielded an $\underline{F}$ of 6.89 ($\underline{df}$ = 4, 116, $\underline{p} < .05$). The significant treatments effect allowed for the necessary comparisons by means of a Tukey Test (Winer, 1962). The Tukey Test showed that the only mean which did not differ significantly ($\underline{p} < .05$) from the transfer obtained with nonrelated pairs was the low Inter-low Intra-Hr A-B group.

Analyses identical with the ones described above were performed on the values obtained with the second transfer measure. Inter-HR was a significant main effect ($\underline{F}$ = 36.44, $\underline{df}$ = 1, 29, $\underline{p} < .05$). Neither Intra-HR nor the interaction term was a significant source of variance ($\underline{F}$ = 2.37 and 1.22, respectively). Again, a significant effect of treatments obtained when all five groups were compared ($\underline{F}$ = 14.65, $\underline{df}$ = 4, 116, $\underline{p} < .05$). The Tukey Tests allowed by virtue of this significant effect show that the differences between the zero-zero word group and all but the low Inter-low Intra-HR group were significant ($\underline{p} < .05$).

Experiment II. Table 45 presents the basic acquisition data for Experiment II. The same transfer measures adopted in the analysis of data from Experiment I were used to adjust for the possible effect of inequalities present in Stage 2 learning of Experiment II. Table 46 shows the mean transfer values for each A-B relationship for both transfer measures.

The same examination was made of the relation between second- and third-stage learning within each A-B group for Experiment II data as was made for the data from Experiment I. The rankings were identical for two A-B groups and there was one misplaced item in each of the remaining A-B groups. On the basis of the apparent relationship between the rankings, the derived transfer data were used in the statistical treatment of the experimental results.

The results of the analysis of variance for transfer measure 1 indicates that Inter-HR was a significant main effect ($\underline{F}$ = 19.86, $\underline{df}$ = 1, 29, $\underline{p} < .05$), while neither Intra-HR ($\underline{F} < 1$) nor the interaction term ($\underline{F} < 1$) was significant. A significant effect of treatments was shown over all five A-B groups ($\underline{F}$ = 20.3, $\underline{df}$ = 4, 116, $\underline{p} < .05$). The results of the Tukey Test indicate that the transfer found in all four A-B relationship groups differed significantly from the transfer found with nonrelated A-B words ($\underline{p} < .05$). On transfer measure 2 neither of the two

TABLE 45

BASIC ACQUISITION DATA: STAGE-2 AND STAGE-3 LEARNING (EXP. II)

Score		Relation				
		High Inter-High Intra	High Inter-Low Intra	Low Inter-High Intra	Low Inter-Low Intra	0 Inter-0 Intra
Total correct anticipations	$\bar{X}$	33.13	39.83	29.87	27.70	33.87
Stage-2	S.D.	12.38	15.98	13.80	14.01	13.87
Total correct anticipations	$\bar{X}$	26.43	31.13	24.13	26.70	18.83
Stage-3	S.D.	11.54	13.55	10.77	12.16	9.69
No. correct anticipations first two trials	$\bar{X}$	2.57	3.23	1.80	2.03	0.53
Stage-3	S.D.	1.54	1.43	1.45	1.66	0.85
Stage-2	$\bar{X}$	22.33				
Trials to criterion	S.D.	6.25				
Stage-3	$\bar{X}$	13.43				
Trials to criterion	S.D.	5.68				

TABLE 46

MEAN TRANSFER VALUES FOR EACH A-B GROUP OF WORD PAIRS (EXP. II)

(3rd stage--2nd stage)

Score	Relation				
	High Inter-High Intra	High Inter-Low Intra	Low Inter-High Intra	Low Inter-Low Intra	0 Inter 0 Intra
Transfer Measure 1	+.271	+.275	+.173	+.137	-.031
Transfer Measure 2	-.066	-.046	-.147	-.090	-.418

relational variables yielded a significant effect (Inter-HR: $F = 2.55$; Intra-HR: $F = 1.33$). A significant main effect was shown when all five groups were compared ($F = 15.45$, $df = 4, 116$, $p < .05$). The Tukey Tests performed on the four A-B means compared with the zero-zero transfer score yielded significant values for all four comparisons ($p < .05$).

The transfer effects found over the total course of learning are similar in the two experiments, with Inter-HR relating consistently to amount of transfer. In the transfer measure concerned with early transfer, neither relational variable had a significant effect on transfer in Experiment II. However, an inspection of the data presented in Table 46 reveals that the difference for Inter-HR, while nonsignificant, was in the same direction as the difference found in the other analyses in both experiments. High Inter-HR yielded greater transfer than low Inter-HR. Low Intra-HR, however, produced more transfer than did high Intra-HR. As in each of the other analyses, the difference between levels of Intra-HR was smaller than the difference between levels of Inter-HR.

The fairly consistent results of both experiments suggest that the amount of verbal transfer in the paradigms tested is dependent upon the degree of Inter-HR of the A-B word pairs across levels of Intra-HR of the same pairs. The results also suggest that degree of Intra-HR does not reliably influence the amount of verbal transfer in the paradigms tested across levels of Inter-HR. There were no indications in those data that the two relational variables tend to act in concert.

CHAPTER 9

EASE OF CONCEPT ATTAINMENT AS A FUNCTION OF ASSOCIATIVE RANK[1]

Underwood (1952) has suggested a method for the study of concept formation which assumes that the attainment of a concept calls for the perception of a relationship between concept instances. The perception of this relationship, in part, depends on the probability of the occurrence of the relevant associative response to the concept instances. This probability is termed response dominance. The mean response dominance of all instances representing the concept is termed dominance level. Underwood and Richardson (1956b) have shown that the ease of attainment of a concept is directly related to its dominance level.

This study explores a methodological variable which determines ease of concept attainment. The variable under investigation is the rank position of the concept response in the associative hierarchy of the concept instance. To the concept instance BELLY the sensory associate ROUND is of Rank 1 with a dominance level of 43% (Underwood and Richardson, 1956a). The sensory associate SOFT is of Rank 2 with a dominance level of 24%. To the concept instance, PAIL the sensory associate METALLIC is of Rank 1 and has dominance level of 24%. While METALLIC to PAIL and SOFT to BELLY are equal in response dominance they vary in their positions in their respective associative hierarchies: METALLIC is of Rank 1; while SOFT is of Rank 2.

This experiment compares ease of attainment of concepts as a function of the rank position of the concepts in the associative hierarchy of the concept instances. For reasons developed below it is predicted that first ranking concepts will be attained in fewer trials and with fewer errors than will second ranking concepts.

Method

Lists. The words used were concrete nouns selected from a list of 213 nouns for which Underwood and Richardson (1956a) have ascertained the dominance level of various responses. As can be seen in Table 47, four groups of instances were assembled: associative Rank 1 (AR 1) WHITE, AR 1 ROUND, associative Rank 2 (AR 2) WHITE, and AR 2 ROUND. This was necessary because of the possibility that the concepts might

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[1] Co-authored by Sarnoff A. Mednick and Sharon Halpern; published in J. exp. Psychol., 1962, 64, No. 6, 628-630.

TABLE 47

CONCEPT LISTS WITH ASSOCIATIVE RANK, RESPONSE DOMINANCE, AND MEAN DOMINANCE LEVEL INDICATED

Associative Rank in Hierarchy	List I			List II		
	Noun	Response Dominance	Concept and Mean Dominance	Noun	Response Dominance	Concept and Mean Dominance
1	Pot	26%	Round 27%	Hospital	32%	White 31%
	Eye	32%		Enamel	28%	
	Dime	30%		Goat	29%	
	Grape	18%		Bread	35%	
2	Frost	34%	White 31%	Badge	21%	Round 24%
	Gardenia	28%		Pill	28%	
	Lard	27%		Waist	24%	
	Bone	34%		Capsule	22%	

differ in difficulty or that concept difficulty might interact with associative rank. List 1 consisted of AR 1 ROUND and AR 2 WHITE while List 2 contained the other two concepts. A buffer concept "LONG" included in both lists (EEL, BEAK, ALLEY, CUCUMBER) was used to make it more difficult for S̲s to attain the concepts by elimination procedures. As is shown in Table 47, the mean dominance levels of concepts were kept nearly constant. In constructing the AR 2 concepts care was taken to avoid having the concept instances elicit a common first ranking response.

The instances were presented to S̲ in three random orders. The same three orders were used for both lists with positions occupied by AR 1 instances in List 1 being occupied by AR 2 instances in List 2. The positions of the buffer terms were not changed between lists, although they were randomized in the three orders that were used.

Subjects. The S̲s were thirty undergraduate paid volunteers. The 15 men and 15 women were divided as equally as possible between the two lists.

Procedure. The lists were presented at a 4-sec. rate on a Gerbrands type memory drum. A 12-sec. interval occurred between presentations of the lists.

The S̲s were informed that the list contained 12 words that could be placed in three groups of 4 words each, and that all of the 4 words in each of these groups could be described by the same adjective. The S̲s were required to respond to each word. The task was continued to a criterion of one perfect trial, or terminated at 20 trials. A more complete discussion of the materials and procedure may be found elsewhere (Freedman and Mednick, 1958).

Results and Discussion

The data which were subjected to analysis were the number of trials to one perfect trial on a concept (this meant giving the correct concept response to all four instances of a concept on the same trial) and the number of errors made on each concept in the entire course of the experiment. As noted above, the buffer concept LONG was omitted from this analysis. AR 1 concepts (List 1, WHITE, List 2, ROUND) were compared with AR 2 concepts (List 1, ROUND, List 2, WHITE). Two List 2 S̲s failed to solve any concept and were dropped from further analysis.

The AR 1 concepts were attained earlier. The mean number of trials taken to solve each concept was 5.90 for the AR 1 concepts and 8.09 for the AR 2 concepts, a significant difference ($t = 2.96$, $df = 27$, $p < .01$). The mean number of errors on the AR 1 and AR 2 concepts were 12.17 and 18.14, respectively. This difference was significant ($t = 2.09$, $df = 27$, $p < .05$).

The results are intuitively satisfying but detailed analysis of their interpretation is somewhat intricate. We have found that AR 1 concepts are attained more easily than AR 2 concepts despite the fact that their dominance levels are equal. Above, we have referred to these ranks as indicating a position in an associative hierarchy. However, this hierarchy is, in a sense, a figment. The norms which provide us with dominance levels and ranks are based on S̲s giving single sensory associates to each of 213 nouns. Actually, while WHITE is a second ranking response to GARDENIA and a first ranking response to ENAMEL, 28% of the norm group gave WHITE as their first and only response to these nouns, and in both cases, 72% gave some other response. Thus, when we refer to these concept responses as occupying positions in an S̲'s associative hierarchy we are making the implicit assumption that the associative hierarchy produced by collating the group's single responses is reflected to a large extent, in each individual. In other words, we are assuming that everyone has just about the same basic associative hierarchy; the fact that we get variation in single response norms we would then attribute to momentary fluctuations in associative strength. Thus, if Underwood and Richardson (1956a), had asked their S̲s to give more than one response to each noun, a large proportion of the 72% that did not give WHITE as their first response to ENAMEL would have given it as their second or third response. If this situation were applied to the present experiment then the superiority of the AR 1 concepts would be understandable. The AR 2 concept responses occupy an inferior position (relative to the AR 1 concept responses) in almost everyone's associative hierarchy. This means the AR 1 concept responses would be elicited earlier in the course of the experiment. This experiment may then be seen as supporting this assumption of homogeneity of hierarchies. Research on word associations (Cofer, 1958; Rosen and Russell, 1957) has contributed considerable support to this same assumption in another context.

CHAPTER 10

A REPLICATION OF FACILITATION OF CONCEPT FORMATION THROUGH MEDIATED GENERALIZATION[1]

Mednick and Freedman (1960) have reported that the prior learning of a paired-associate list facilitates the attainment of selected concepts when the paired-associate list is constructed in accordance with a mediated generalization paradigm. Thus, for example, in order to facilitate the production of the concept response WHITE to the concept instance SUGAR prior pairing of the words SUGAR-BLACK was given in a paired-associate list. It was assumed that the word BLACK elicited the implicit response WHITE causing the word WHITE to occur in contiguity with the word SUGAR, strengthening the association SUGAR-WHITE. When *S* was subsequently presented with the instance SUGAR in the concept formation task, the attainment of the concept WHITE was facilitated.

The present study attempted to replicate this result with an N of 100 undergraduate students consisting of 43 males and 57 females.

Results. The mean number of trials to attain the facilitated and the nonfacilitated concepts was 12.83 and 13.70, respectively. This difference was not significant, $t\ (99) = 1.32$, $p < .10$. The mean number of errors made on the facilitated and nonfacilitated concepts was 33.05 and 41.61, respectively, a significant difference, $t\ (99) = 3.18$, $p < .005$. The mean trial on which the first correct instance of the facilitated and nonfacilitated concepts occurred was 5.84 and 8.43, respectively, a significant difference, $t\ (99) = 2.78$, $p < .01$. In addition to the above analyses performed by Mednick and Freedman, an analysis was made to determine whether the instances of the facilitated concepts were more easily elicited during the early trials. The mean number of different correct instances for the facilitated and nonfacilitated concepts in the first four trials was 1.64 and 1.09, respectively, a significant difference $t\ (99) = 2.75$, $p < .01$. Further, the number of *S*s showing more different facilitated than nonfacilitated instances in the first four trials, showing an equal number, and showing fewer was 49, 27, and 24, respectively, $x^2(2) = 11.18$, $p < .005$. In computing this chi square we conservatively assumed a chance distribution of *S*s in the three categories.

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[1] Co-authored by Sarnoff A. Mednick, Jerry Higgins and Susan L. Taylor, and published in *J. exp. Psychol.*, 1963, *65*, No. 4, 421-422.

It may be noted that Mednick and Freedman's Ss were somewhat superior in the ability to form both facilitated and nonfacilitated concepts to the Ss used in the present study. This difference may be attributable, at least in part, to the nature of the two groups. The Ss in the original study were unpaid volunteers, while the Ss of the present study were paid volunteers and students fulfilling a requirement of an introductory psychology course.

In summary, all results of the replication experiment were in the direction of facilitation; all but one were statistically significant. It is concluded that the facilitation of concept formation through mediated generalization is a replicable phenomenon.

FINAL SUMMARY

This program of research was guided by an associative theory of creative thinking. While the theory is essentially concerned with explaining thought processes, it also appears to have implications in a variety of areas of psychological functioning. Much of the research attempted to explore the usefulness of associative theorizing in some of these different areas. Disparate as the results of our research probes may seem, there are two unifying themes: one of course is the associative theory itself, and the other is the concrete, operational definition of creative thinking, the RAT.

The following summary focuses mainly on the second theme. It is an attempt to compose, from the results of the various studies, a succinct description of some of the characteristics related to RAT performance. This represents a culling of major findings, integrating also our early work with the test and theory, as well as some pertinent results by other investigators. The reader is urged to use this summary as an "index" and refer to the cited references or to the appropriate chapters in this report for greater detail.

We have organized this resumé into the following sections: (1) Associative characteristics, (2) Intellectual and other ability factors, (3) Motivational characteristics, (4) Personality, interests and attitudes, (5) Developmental and social characteristics. A final section summarizes the evidence on the criterion validity of the RAT.

Associative Characteristics

Highly creative individuals have a richer associative life than less creative persons. They can produce a greater number of associations to a wide variety of stimuli.[1] They also show associative endurance; their rate of idea production does not drop off as rapidly as it does for the less creative individual (Part III, Chapter 1). In addition, their associations are unusual (see Table 10) and less dominated by a single idea (as manifested by their flat associative hierarchy). Furthermore, their associations are likely to vary from occasion to occasion (Part III, Chapter 2). When asked to make four-letter words from the word "generation" they tended to produce a higher proportion of unique words as well as more words (Part I, Chapter 2).

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[1] To avoid wearisome repetition we shall frequently leave comparative statements dangling, leaving the reader to infer the phrase "than the low creative."

This associative originality is accompanied by a higher "quality" of response. A finding by MacArthur supports this. He examined Rorschach performance of high and low creatives, and found that the percentage of original responses (0%) and the percentage of original responses of poor quality (0-%) correlated .01 and -.20 respectively with RAT performance. However, original responses of superior quality (0+%) correlated +.26 with RAT performance, a significant relationship.[2]

Intellectual and Other Ability Measures

With respect to standard measures of intelligence, the correlations we have obtained indicate that the high scorer on the RAT also tends to be in the upper IQ range. The correlations range from .34 to .59 for various verbal IQ measures (see Table 10). In the nonverbal area the picture is not quite as clearcut, with a finding of -.41 on one mathematical aptitude test, .19 on another, and .40 on the Minnesota Engineering Analogies Test (all significant). It was, however, clear in our study of research creativity in graduate students (Part II, Chapter 3) that verbal ability measures, while related to RAT performance, do not predict to ratings of research creativity. We therefore have concluded that while an individual must be at a high level of verbal intelligence to be capable of good performance on the RAT, other factors are involved in his ability to perform in a creative manner. This kind of result also held true for the criterion validity study conducted with the students of architecture (Part I, Chapter 2, Table 10). While the RAT and the Terman Concept Mastery Test were significantly related, it was only the RAT which predicted the ratings of creativity in design.

With regard to other ability measures, one of our most consistent findings has been that RAT scores are negatively correlated with grades. In the sample of creative architects (Part I, Chapter 2) RAT scores correlated -.34 with their self-reports of college grades. In a group of engineering students RAT scores and grade point average (GPA) correlated -.27; in a group of psychology graduate students, GPA and RAT scores correlated -.11 (Table 10). Two studies have shed a degree of light on this recurrent observation. Walker (1962) found that the grades of high creatives were more variable than those of low creatives. Miller (1960) found the grades of low creatives were not affected by the "flexibility" of their instructor; on the other hand, high creatives tended to obtain lower grades from less "flexible" teachers, and higher grades from more "flexible" teachers. This may be one of the bases for the higher variability of grades in Walker's high creative group. This variability or inconsistency may also be depressing the GPA of the high creative, thus producing the low negative correlations with RAT scores. This is also an interesting finding in combination with the fact that RAT performance and several measures of intelligence have been positively and significantly related. Assuming that the IQ scores predict GPA, we have again an instance of a different kind of prediction holding for the RAT.

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[2] Personal communication from Dr. Charles MacArthur of the Harvard Student Study.

Another question which has been raised deals with the problem of training or educating for greater creativity. A good deal of effort is being expended by researchers and practitioners in procedures intended to increase creativity. This question has obvious importance for educational practice. The results to date suggest that while training procedures can increase originality (unusual, but not useful, responses), they do not influence creativity (unusual responses which do meet specified requirements). Maltzman (1961) attempted to increase RAT scores using associative techniques which he had shown to be successful in incrementing originality scores. These associative techniques were only successful in improving RAT performance in the case where a dominant association of the correct answer, i.e., a strong hint, was provided. For more general purposes such creativity training would not be overly advantageous since it would be useful only where the creative solution was already known. Caron, Unger, and Parloff (1963) criticize the Maltzman technique for much the same reason. With some methodological variation they repeated the Maltzman study and concluded that these associative techniques did not affect RAT performance. On the other hand, Freedman (1965) did report success in facilitating RAT performance using a variant of the Maltzman procedure. The original Maltzman procedure requires the subject to give a different associative response to a verbal stimulus each time the stimulus is presented. Freedman presented the stimulus word only once and asked the subject to associate repeatedly to this word for 30 seconds. This procedure preceding RAT testing did facilitate RAT performance over that of two well-chosen control groups. Freedman attributes the success of this attempt to the training that the subjects received in producing many associations in a brief period to a single verbal element. Because of the small number of subjects used, it would have been of value to have equated groups for RAT performance before the institution of the experimental procedures. However, the study of this new and successful procedural twist should be pursued. If creative performance can be enhanced in this manner in the laboratory situation, a real-life test in an educational setting would definitely be in order.

Motivation

We have thus far attacked two of many possible questions in the area of motivation. The first, in the domain of drives, asked what pushes an individual to behave creatively rather than to conform. The other concerned the relationship of personal conflict to creative performance.

The study with Houston (Part III, Chapter 4), hypothesized that the creative individual is driven by a need for associative novelty. In order to demonstrate that this need for associative novelty has characteristics similar to drives such as hunger and thirst, it was reasoned that such a need could be reduced by providing the individual with novel associative material (just as the hunger need is reduced by the provision of food). Any behavior sequence which is systematically followed by such drive reduction should be reinforced and show an increase in frequency of occurrence. The high and low creative subjects were confronted with two words, a noun and a nonnoun, on a card and asked to read aloud the one they preferred. If the subject chose the nonnoun, e.g., "black," the experimenter responded with a trite association, e.g., "black-white." Choice of the noun, on the other hand, was followed by a novel association, e.g., "father-eggbeater." If the novel association was indeed reinforcing to the high creative subjects, then their rate of choosing nouns would be expected to increase; such a relationship was observed. It was also of great interest that the low creative tended to increase their choice of nonnouns as if they were avoiding the (noxious?) novel associations or as if they were being rewarded by the trite associations. The results suggest that a need for associative novelty may be one of the important motives influencing, if not instigating, creative behavior. Perhaps the satisfaction of this need is in part responsible for the strong feelings of satisfaction (aha! experience) which have often been reported to accompany the attainment of creative solutions (Ghiselin, 1952).

Dr. Marion Lahn's dissertation undertook to determine the role of conflict in creative thinking (Part III, Chapter 5). She administered a word association test (WAT) and a remote associate task. The WAT was composed of all the words from the remote associate items. She then determined whether WAT conflict indicators for given words were related to poor performance on the items in the remote associate task. She found that the amount of conflict shown on the WAT was related, albeit in a complex manner, to performance on the remote associate task. The effect of conflict on specific items depended on their difficulty level. When the items were difficult, conflict concerning the component words tended to depress performance; in the case of easy items, conflict actually tended to improve performance. Total amount of conflict was not related to overall performance on the remote associate items. It might be concluded that, within limits, a person's level of conflict will not interfere with his creative performance unless he is conflicted about materials or ideas which are specifically related to the immediate problem. This evidently holds for tasks requiring high levels of creativity; on less demanding tasks, conflict concerning the materials may in fact be an asset.

Personality, Attitudes, and Interests

The nature of the relationship between RAT performance and personality measures was first suggested when the test was included with a battery of self-report items in a study of a large group of University of Michigan undergraduates. None of the empirical scales related to RAT performance; the number of individual items relating to RAT performance was fewer than chance (W. Norman, personal communication). Newcomb et al. (personal communication) administered the RAT to the students at Bennington College and a freshman class at the University of Michigan along with a battery of personality measures. The same result obtained: RAT performance was not related to any of the personality measures used. At Harvard University, King administered the RAT and a very extensive battery of personality tests to an entering freshman class; he obtained similar results (personal communication). The most reasonable conclusion appears to be that *there are no specific personality characteristics associated with creative potential* as measured by the RAT. The major exception to this general conclusion concerns the tendency of high scorers to evidence independence, autonomy, and nonconformity. In one study, a group of 40 creative architects was tested with the Crutchfield adaptation of the Asch conformity experiment. In this simulated group situation, the architects were asked to make a variety of aesthetic judgments and were provided with judgments which they were led to believe were made by their fellow architect-subjects. In all cases the "peer judgments" preceded the individual architect's response and were completely controlled by the experimenter. To what degree would the architects conform to the apparent "peer judgments?" Within the group defined as creative, the high RAT scorers tended to show less conformity than low scorers (Table 10). The RAT has been shown by Karp (Part I, Chapter 2) to be related to the variable of field-independence (Witkin, et al., 1954); the high creative individual is more field independent. In a study of research scientists in industry, high RAT scorers working in research groups were able to manifest their creativity more when these groups were rated as "uncoordinated," or where the scientist had more autonomy (Part III, Chapter 7). That autonomy and creative ability interact in quite a complex manner is shown in a study by Dodd (1962) on a group of 42 IBM research engineers and scientists. High creatives who were high on autonomy liked their research work and shunned administrative responsibilities. Low creatives who were high on autonomy preferred administrative responsibility.

With respect to interests, the keys of the Strong Vocational Interest Blank (SVIB) which attract the highly creative subject are Artist, Psychologist, Musician, Mathematician, and Author-Journalist. The low creative subject is attracted to the Farmer, Math-Physical Science high school teacher, Office Manager, Production manager and Pharmacist keys. The keys preferred by the high creatives have a smaller overlap with the preferences of the general population than the keys preferred by the low creatives. Thus their preferences are relatively original (Kowalski, 1960; Mackinnon, personal communication, 1961).

Kowalski (Part I, Chapter 2) questioned a group of freshman women concerning their attitudes toward women's rights and sexual behavior. The highly creative girls tended to hold more "liberal" attitudes toward sexual behavior and to advocate support of equal social and professional rights for women.

Developmental and Social Characteristics

In studies of both high school students and research scientists, we find that the highly creative individual tends to come from a family of relatively high socioeconomic status (Chapter 6). His childhood rearing conditions interact to a great extent with his level of intelligence. Within a high-IQ group, creative children (as opposed to less creative high-IQ children) are accorded a good deal of training which would tend to build-in internal controls. Their relationship with their mother seems to be relatively close. Except for these factors, differences in rearing conditions for the (High-IQ) high and low creative groups are not great. On the other hand, differences between low and high creatives are considerable in the relatively low-IQ groups. The parents of the low-IQ, highly creative children tend to come from rural environments and appear to be more consistent in obedience training. The father reports higher occupational aspirations for his son; the parents are concerned about providing a good home environment for studying. Within this group also, we find the mother to be closer to the highly creative child. In the low-IQ group, the highly creative child also shows a higher nonverbal intelligence, is judged to be better in class work, self-confident in solving new problems, more capable of leadership and better liked by his elementary school teacher.

The highly creative research scientist tends to have attained his bachelor's degree at a relatively young age. When observed as a physical scientist in industrial settings, he has previously held a wider variety of types of jobs. When asked, he disclaims an interest in mapping out broad features of problems and seems to prefer to work on specific research tasks. He tends to have been in his research groups a relatively short time and professes a preference for a "lone wolf" approach to his work. This agrees with the previously mentioned finding that the highly creative scientist prefers an autonomous work situation (Chapter 7; Dodd, 1962).

Results of Criterion Validi[illegible] Studies

This section deals with material related t[illegible]e criterion validity of the RAT. Two types of studies are included. The first uses judgments of subjects as criteria of the subjects' creativity; the second uses judgments of the subjects' products as criteria of his creativity.

Judgments of Subjects as Criteria. The first criterion validity study (S. Mednick, 1962) made use of an older form of the test. It was administered to a group of architecture students whose creativity had been rated by design instructors who had worked with them for up to two years. The RAT and the ratings correlated significantly ($r = .70$, 19 df, $p < .01$). In another study, M. Mednick (1963) obtained judgments of the creativity of psychology graduate students at two universities from their research advisors. These ratings correlated with RAT performance ($r = .55$, 42 df, $p < .01$). On the other hand, Andrews (1962) found essentially zero correlations between supervisor ratings of the creativity of research scientists and engineers working in several government laboratories and their RAT scores. Andrews also used ratings based on performance but these also yielded zero correlations in this setting. He found that RAT scores did correlate with his creativity criteria under certain conditions favoring the independence and power of the subjects. Chiranian (personal communication from G. Gordon) also found that RAT scores and supervisor judgments of creativity were not related.

Judgment of Products as a Criterion. In addition to supervisor judgments Chiranian had information on research proposals that his scientist subjects had prepared. The number of such proposals was related to RAT performance ($r = .29$, 56 df, $p < .05$). Of those 82 proposals that won contracts, 75% had been written by scientists scoring above that group's median on the RAT. Twenty-five per cent of the successful proposals had been prepared by scientists scoring below the group median ($p < .01$).

Dodd administered the RAT to a group of IBM employees who had won suggestion awards. He found that the number of such awards won and RAT scores correlated .44 ($N = 22$). He had verbal fluency measures on this group which were positively related to RAT performance and negatively related to the criterion. When verbal fluency was partialled out of the RAT-criterion correlation, this correlation was raised to .53 (Dodd, 1962).

Dr. Polly Mosteller had fourth graders at the University School of the University of Michigan produce a series of standardized paintings. She had three professional artists who did not know the children judge the paintings for artistic qualities. The elementary school form of the RAT had been administered to 26 of these children as part of an earlier study. The relationship of RAT performance to these artistic qualities are shown in Table 48 (Mosteller, 1962).

TABLE 48

RELATIONSHIP BETWEEN ARTISTIC ABILITY AND RAT PERFORMANCE

Artistic Quality	Correlation with RAT
Aesthetic	.48
Color	.58
Composition	.44
Symbolization[a]	.17
Vitality	.41
Perspective-Depth[a]	.13

[a] Mosteller found these measures to be highly related to intelligence and specific training.

In conclusion, it can be said with considerable assurance that the validity of the RAT as a measure of creative thinking has received substantial support. Its predictive value has held in a variety of settings and with a variety of subjects. The experimental verification of hypotheses emanating from the theoretical orientation has also amplified our understanding of test results. In each area further work is needed and will be carried out.

APPENDIX

REMOTE ASSOCIATES TEST

FORM 3

Sarnoff A. Mednick
Martha T. Mednick
The University of Michigan

NAME: ____

CLASS: ____________________ SCHOOL: ____________________

SEX: ____________________ DATE OF BIRTH: __________ DATE: __________

INSTRUCTIONS: In this test you are presented with three words and asked to find a fourth word which is related to all three. Write this word in the space to the right.

For example, what word do you think is related to these three?

A. cookies sixteen heart __________

The answer in this case is "sweet." Cookies are sweet; sweet is part of the phrase "sweet sixteen," and part of the word "sweetheart."

Here is another example:

B. poke go molasses __________

You should have written "slow" in the space provided. "Slow poke," "go slow," "slow as molasses." As you can see, the fourth word may be related to the other three for various reasons.

Try these next two:

C. surprise line birthday __________

D. base snow dance __________

The answers are at the bottom of the page.

Now turn this page over and try the groups of words on the other side. Many of these are not easy and you will have to think about some for a while. If you have trouble with some groups of three, go on to the next and come back to them later. You will have 40 minutes.

Make sure your name is on this test.

The answers are: C. party; D. ball.

Instructions for group administration of the Remote Associates Test.

1. Each student will receive an IBM answer sheet, IBM pencil and RAT booklet.

2. The IBM answer sheets should be distributed first. Have the pupil *print* his name, the name of the school, sex, class, and homeroom on the sheet. Any other pertinent identifying data should be recorded at this time. Do *not* give out the RAT booklets until you explain the answering procedure.

The answer to each test item will be recorded *two* times; it is written first in the test booklet and then the same answer will be recorded on the IBM answer sheet.

As you can see, the answer sheet contains lines *numbered* 1-30, and columns *lettered* A-Z, except for "X." The answer is always a single word. The word is written in full in the booklet. Then, using the special pencil, the space next to the appropriate item number beneath the letter on the IBM sheet which is the *first* letter of the answer should be filled in. For instance, if the answer to item #1 is *rain*, the word "rain" should be written in the booklet and then the answer space beneath the letter "R" for item #1 should be blackened.

3. Following this explanation, the booklets and IBM pencils may be distributed. Ask students to record identifying data on the booklets. At this point, the test instructions printed on the face of the booklet should be read aloud while the examinees follow along.

4. A signal for students to begin working should be given. The test takes 40 minutes. Another signal should be given after fifteen minutes have passed. It is advisable to have the IBM answer sheets inserted into the booklets in order to assure accurate identification.

NAME ____________________ DATE ________
LAST FIRST MIDDLE

SCHOOL ____________________ CITY ____________________

A. ____________________ B. ____________________

SCORES

1. ______ 5. ______
2. ______ 6. ______
3. ______ 7. ______
4. ______ 8. ______

DATE OF BIRTH ________ ________ AGE ____ Yr. ____ Mth. ____ SEX ____ (M or F)

CLASS ________ PARENT'S OCCUPATION ____________________

C. ____________ D. ____________ TEST FORM ________

1 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
2 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
3 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
4 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
5 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
6 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
7 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
8 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
9 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
10 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
11 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
12 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
13 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
14 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
15 A B C D E F G H I J K L M N O P Q R S T U V W Y Z

16 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
17 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
18 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
19 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
20 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
21 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
22 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
23 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
24 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
25 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
26 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
27 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
28 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
29 A B C D E F G H I J K L M N O P Q R S T U V W Y Z
30 A B C D E F G H I J K L M N O P Q R S T U V W Y Z

[illegible] PRINTED IN U.S.A. [illegible]

Check-List Rating Scale for Creativity

Student Rated:________________________ Rated by:____________________

Place a check mark in the space to the left of each statement which applies to or describes the student being rated. Statements which do not apply should be left blank.

( ) He often introduces minor innovations but rarely, if ever, makes a markedly original contribution. (33)[b]

( ) He contributes more of his own ideas to the problems he works on than does the ordinary student. (51)

( ) Given an unfamiliar problem, his first impulse is to consult a book or another person. (17)

( ) By comparison with other graduate students in this field, he is outstandingly creative. (66)

( ) Like most students, he occasionally devises an improved method or piece of equipment. (42)

( ) He never has an idea of his own to suggest. (10)

( ) Some of his ideas, while original enough, are also silly or bizarre. (37)

( ) He shows signs of being one of the most creative students in this field that I have known. (68)

( ) He does not have a great number of new ideas. (25)

( ) He frequently has ideas. (45)

( ) He has suggested many entirely new problems. (61)

---

[a] Based on a scale devised by Donald W. Taylor, (1957).

[b] Note that the numbers in parentheses, the scale values, did not appear on the scale when administered to the raters.

( ) He is somewhat hesitant about trying to work through a new problem entirely on his own. (27)

( ) Now and then, he works out a somewhat ingenious hypothesis. (49)

( ) Characteristically, even when faced with new problems of some complexity, he tries to think things through in his own terms. (56)

( ) He seldom contributes new ideas. (2)

( ) Once in a while he has an original idea. (32)

( ) More than once he has thought of new ways of looking at results. (54)

( ) Left to himself, he might have difficulty thinking up problems to investigate. (22)

( ) Invariably, his approach to anything is original and fresh. (63)

( ) He does an adequate, but not an outstanding, job of outlining new research proposals. (39)

( ) His ideas are more likely to be conservative, rather than revolutionary. (28)

( ) He has worked out on his own, applications of his results to other problems or fields. (58)

( ) He requires detailed instructions before he sets about a new project. (14)

( ) He is something of an independent thinker. (47)

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